SAFEGUARDING FOOD SECURITY IN VOLATILE GLOBAL MARKETS

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Safeguarding food security in volatile global markets

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Preface

The world is again experiencing a bout of heightened and prolonged price volatility in global food markets. Historically, occurrences are rare and each time they transpire, the world's attention is temporarily galvanized, but concerted follow-up action has always fallen short of momentary expectations. The failure to prevent history from repeating itself is troubling, particularly when contrasted against other global systems that come under threat. When, for instance, financial crises take hold, the depth, breadth and rapidity of a coordinated response by the world's leaders in marshalling resources to remedy imbalances demonstrates that global action is possible. When the world food order falters and millions forego food security, however, the resolve of global leadership fails.

The impasse on inaction must be broken. Shielding food security against the threat of more frequent bouts of turmoil in global food markets must now be put at the top of the political and economic agenda. Hence, there is a clear need for a new policy dialogue.

Opening the policy dialogue is likely to provoke controversy. Not least because of certain new and important realities now facing the global food system. One reality concerns the large-scale financial investment in commodities that are key to food security. Soaring investment activity is exposing price discovery in the food system to a new behavioural dimension, which may underlie excessive price volatility in markets. Biofuels are another prominent reality. During times of global food scarcity, regimes that support the production and demand of grains-based biofuels, which produce dubious environmental benefits, can be construed by many as reprehensible. Finally, changes in climate and global demography that require adaptive responses to food productivity growth to ensure feeding future billions is another reality.

Towards the policy imperative, this volume collates the latest thinking on the potential for achieving food security in volatile global markets. Much rests on the concept of "global governance" - building consensus on optimal policy choice and enhancing policy coordination. Global governance has important implications for shaping a more stable market environment; for instilling greater confidence, predictability and assurance in the international arena; for guaranteeing access to food for low-income countries and for better equipping governments to deal with the challenges ahead.

But governance has a role within geographical boundaries. There are a host of initiatives that countries at risk can promote. These are principally directed towards building resilience and lowering vulnerability through investing in productivity for a diversified set of crops supported by incentive frameworks, instilling greater efficiency in domestic food systems and protecting those most at risk through safety nets. Enacting such measures will not only address the root cause of vulnerability, namely poverty, but would constitute a major step

towards tackling the problem of hunger and malnutrition that still afflicts one billion people in the world today.

This volume is the product of a small team of dedicated individuals who mutually regard the book's importance in the times we face. Acknowledgement is given to the assistant editor, Matthieu Stigler for his technical oversight and management support in producing the book, to Michelle Kendrick for her overall guidance, and to Natalia Ermolaev, Adrianna Gabrielli, Ann Berg and Jim Greenfield for editing and reviewing the content. Acknowledgement is also handed to Fiorella Picchioni for help in putting together the material, and to Claudio Cerquiglini, Rita Ashton, Marco Milo and Josiah Prakash for assistance with graphic design. Finally, credit goes to the contributors, for without their diligence, this volume would not have been possible.

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Foreword

Following the global distress caused by sustained food price elevation during 2006-2008, FAO has endeavoured to strengthen its analysis of the issue of food price volatility. To raise awareness of the problem of food insecurity, FAO has led an effort to gather new ideas from experts and institutions to help shape a policy debate that is relevant to today's environment. *Safeguarding food security in volatile global markets* is a comprehensive book which provides a fresh approach to the multiple challenges facing the world's agricultural policy designers. Premised on a new reality of heightened food price unpredictability, the book illuminates the problems faced by billions of people living in a volatile price environment – one in which food security is worryingly compromised. In addressing an outlook of increased systemic price shocks, the book explores the past, present and future policy responses through the perspectives of multiple actors, analysts and policy-makers in the world food arena.

The book is controversial. Many of the chapters address topics that are hotly debated on a daily basis in the media or economic journals. Climate and demographic change, trade policy, speculation on futures markets, market intervention vs. coping mechanisms, sovereign risk management and the role of global governance comprise the subjects of chapters in the book. FAO intends that this book will act as a platform for a diverse range of viewpoints and prescriptions – both hypothetical and practical – in order to encourage a proper debate.

The book is unique. Rather than approaching food security from a single vantage point, it provides numerous theoretical frameworks for addressing the issue. Because food scarcity affects everyone, but can be devastating to the most vulnerable, fresh thinking – that defies ideological categorization – is a welcome feature of the book.

Finally, the book is timely. Governments are only beginning to grapple with the structural changes that are permanently altering the food security landscape. The G-20 has committed to a Multi-Year Action Plan on Development (Seoul, 2010) which endorses the Rome Principles, specifically to, "Mitigate risk in price volatility and enhance protection for the most vulnerable" Policy-makers will be able to use the book as a resource and reference to the multitude of issues that need solving through informed decision-making, *viz.* policy initiatives, regulatory reform and investment.

FAO believes that improving food security is one of the most pressing issues of our time. The structural changes brought about by globalization, growth in international markets and trade and technological innovation are rapidly changing the global food production and distribution landscape, leaving millions vulnerable to price shocks. *Safeguarding Food Security in Volatile Global Markets* provides a core foundation for those entrusted with the complex task of making food security a reality for all.

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Rome, March 2011

Overview

This four-part volume gathers together the latest thinking on the issues and controversies surrounding price volatility in global food markets. Drawing from theory, empiricism and heuristic evidence, the book contributes to the debate on the causes, consequences, and challenges of food price volatility. Food security and vulnerability are placed at centre stage, especially in their demands on shaping innovative policy design.

In setting the stage, PART ONE of the book defines the problem and asks why volatility matters. For the purpose of economic enquiry, the book characterizes volatility by the concepts of variability and uncertainty; variability describes overall movement while uncertainty refers to unpredictable movement. As households and planning agencies are able to cope with predictable variation, however, unpredictable changes – or "shocks" – are of primary concern.

Popular discussion often confounds volatility with high prices. It is possible for prices to be high but show little variability, or to be low but variable, but in practice, price levels and volatilities tend to be positively associated. This is largely owing to low carryover, which reduces current availability, exerting upward price pressure, limiting the possibility of using inventories to respond to positive demand or negative supply shocks, and thereby increasing volatility.

Regular price fluctuations – "day-to-day" or "normal" volatility – are both a typical attribute and a requisite for the functioning of competitive markets. The essence of market functioning is that when a commodity becomes scarce its price rises, which induces a fall in consumption and signals more investment in the production of that commodity. Importantly, there is a need to know why prices have risen to counteract the scarcity in an efficient way. But the efficiency of the price system begins to break down when economic shocks give rise to price movements that are increasingly uncertain and precipitous, and in the limit the system becomes largely redundant when prices undergo "extreme volatility" – or "crisis" to use popular terminology. Since when shocks surpass a certain critical size or threshold and persist at those levels, traditional policy prescriptions and coping mechanisms are likely to fail.

Historically, bouts of extreme volatility in global food markets have been rare. To draw the analogy with natural disasters, they typically have a low probability of occurrence but bring with them extremely high risks and potential costs to society. Being global events, they pose extreme covariate risks, and present the greatest challenge to policy-makers. However, there are signs that portend to the rising vulnerability of the global food system to large, exceptional shocks from a growing number of uncertain sources. Indeed, the stability of the global food system can no longer be taken for granted.

The seeds of crisis sown in past events change little, for instance the 1974 crisis and the 2006-08 turmoil, but time and again, policy-makers and the multilateral agencies have failed to prevent history from repeating itself. Complacency is partly to blame, but culpability can also be attributed to over-supplied markets and ensuing low prices which dominated the period after the 1974 crisis and further, a new policy doctrine enshrined towards dependence on global markets. By assuming world prices as a reference for measuring economic efficiency, trade liberalization would enhance resource allocation through exploiting comparative advantage. This increased reliance on markets was also concomitant to a progressive withdrawal of the state and intervention schemes from the food and agriculture sector, on the grounds that the private sector was more efficient from an economic point of view.

Against these trends, public and private sectors in both developed and developing countries saw a limited need to invest in agricultural production and infrastructure, as food imports appeared an efficient way of achieving food security. Such perceptions, though, were radically changed when in 2006 prices of most internationally traded foodstuffs began to soar.

Episodes of extreme volatility are a major threat to food security in developing countries. Typically, low-income food-importing countries that are dependent on foreign aid and are characterized by high levels of foreign debt are the most vulnerable to positive food price shocks. The detrimental impact of rising volatility on these economies rests on their structural disposition: poor infrastructure, poor supply response, incomplete markets, weak capacity to import, sovereign risk, dependence on a single dominant staple, and susceptibility to climatic disturbances. Rising volatility can, in countries falling under this typology, increase the incidence of poverty, as well as putting a strain on government expenditure and borrowing, thus worsening debt sustainability. The deterioration of the terms-of-trade may destabilize the economy, thus impeding economic growth.

Despite the lack of academic consensus on the magnitude of these costs, the most compelling cases for the negative effects of high and volatile food prices can be made for its welfare impacts on household food security and the manner by which it overwhelms coping mechanisms and undermines investment incentives. Structural issues preclude good times compensating for the bad times, which leads to irreversibility of impact on societies.

Acknowledging the sheer pressure on global agriculture if it is to meet the challenge of a rising global population - a doubling of food production required in developing countries in the four decades to 2050 - there remains little scope for productivity growth to deviate from this task without instigating further bouts of turmoil. However, achieving this task remains far from certain. Beyond the uncertainty driven by environmental factors, including a changing climate and land degradation, the trajectory of the global food system is no longer in the main determined by the resolution of demand and supply fundamentals. External shocks are emerging from a complexity of sources and are having a profound influence in shaping the agricultural landscape. Many of these shocks transcend international borders, spilling over from other sectors, and have the potential to amplify and perpetuate volatility. Their complexity compounds uncertainty, and is driving vulnerability in food systems.

In this vein, there is a strong case that volatility is both a cause and consequence of vulnerability. The argument is framed in the context of both the resilience and response of food systems to shocks. When shocks are large – exceptional shocks – they can instigate a vicious cycle of rising fragility in response mechanisms that deepen and perpetuate volatility and its negative impacts on food security. The growing exposure of vulnerable countries to bouts of market volatility is a challenge to all, and beckons the question of what policies governments should pursue to cope with an increasingly unpredictable environment, especially in the longer term.

PART TWO reviews past policy responses during episodes of turmoil. It is seen that authorities, including marketing boards in vulnerable food deficit nations, have attempted to intervene, but in most instances, budgetary constraints and the sheer scale of price increases have precluded any meaningful success at stabilization. Accordingly, interventions have been short-term, limited to the micro-level such as targeted consumer subsidies and safety nets and also to policies at the border, such as lowering tariffs and restraining exports. For illustrative purposes, this section of the book explores how the lack of policy coordination among major producing and consuming countries, instigated exceptional bouts of turmoil in global markets, especially for rice.

Part two also elucidates on the disingenuity of more recent initiatives advocated. These proposals often abound in calling for a return to market management and control, ranging from coordination of supplies, either through national or global buffer stocks, including international commodity agreements (ICAs), to indirect market interventions via so-called "virtual stocks" in organized exchanges. However, such proposals suffer from the fact that any policy that purports to manage the fundamentals of a commodity market, cannot control the actions of myriads of private agents that are a feature of all food markets. Moreover, speculators can normally counteract the actions of all but the most well financed intervention activities.

While it would be incorrect to claim that ICAs failed, they have not had significant success in reducing the volatility of the prices they set out to stabilize. By restricting exports, they probably did succeed in raising prices but this is not helpful in the current context in which the international community wishes to limit food price variability, or at least limit its effects. Many commentators have reverted to public sector storage as a possible response to apparently inadequate private storage. However, public storage crowds out private storage so the mere introduction of a public storage programme increases the problem that it was designed to solve. Public storage is therefore costly; moreover, it is unlikely to be very effective in countering price spikes as the storage authority can only sell what it has previously bought. The knowledge that it cannot counter price spikes will leave it vulnerable to speculative attack. The history of buffer stock storage in the international commodity movements bears out these views.

An important "new reality" of the global food system that has sparked considerable controversy and debate, often polarized, concerns the influence of commodity speculation on food prices. On one side, it is recognized that speculation is crucial to the proper functioning of markets, there is strong conviction that unlimited speculation is not. The central argument here is that once speculation becomes "excessive" - to the point that the marginal benefit of the liquidity that speculators provide exceeds the marginal cost of the damage that they do to the price discovery function - there is need for intervention. As the prices broadcast from the major commodity exchanges reverberate around the world and affect billions of lives, a serious and more directed inquiry into the trading on the international commodity futures markets should commence.

As traded food security commodities are now firmly established in the investment class of financial assets, **PART THREE** of the book examines the role of information and expectations by investors in destabilizing the price system. In particular, how "excess volatility" might arise given the behavioural dimensions of markets when traders possess diverse information. Though much of what is conjectured in part three has intuitive appeal, given that data supporting theoretical mechanisms and underpinning behaviour are unobservable, this limitation confounds testing hypotheses in standard models and so robust empirical evidence is by and large absent. An important, though fairly self-evident point, is that if "fair price" or "fundamental value" could be observed, it would be straightforward to measure the excessiveness of volatility in prices. Only a new methodological approach - one that analyses orders and transactions, segregated by trading types - can start to separate fact from fallacy.

In addition to extreme volatility as an outcome of irrational behaviour, it is also seen that the phenomenon could equally be a rational response to when working stocks fall critically low. In regimes of high volatility that are determined by the level of inventories of leading international suppliers, "bad news" creates "panic" and has a much more dramatic impact on the market behaviour and sentiment than when stocks are ample. More generally, analysis in this part of the book shows the importance of stocks (via the competitive storage model) in explaining the most prominent features of the dynamics of commodity prices, including episodes of isolated price spikes and conditional high price volatility. As for policy, it might be tempting to infer that the corollary of this conclusion would be to increase inventories *per se* to prevent turmoil and crisis. While this may be true to diffuse the prospect of isolated turbulence in domestic markets, or if Malthus proves to be right, in that global scarcity in food markets becomes critical, ample and highly liquid *commercial* stocks held by major grain exporters appear a necessary and sufficient condition to instil confidence in world markets and to lessen the probability of future bouts of extreme volatility. This point also adds credence to the earlier conclusion that private non-distortionary stockholding in the market place has a far more effective role than does public stockholding.

Given the realities of the current world food system and the absence of, or at best limited, success of past interventions, **PART FOUR** argues the need for a new policy dialogue. Beginning with the multilateral trading system, World Trade Organization rules and disciplines are much less effective in situations of high world market price than they are in cases of depressed prices. This asymmetry is largely a consequence of the original objective of this system that aimed at disciplining situations leading to depressed prices in world markets adversely affecting exports. Thus, domestic and export subsidies, as well as import barriers, have been the target for reform, while policies that have the opposite effect (such as export taxes and prohibitions) have been largely tolerated. But the extent to which the fundamentals of world food markets have changed, the multilateral rules must adjust accordingly to be able to address trade issues that arise when food is no longer cheap. This would also add to the credibility of the system and foster an environment conducive to more trade openness on the part of importing countries, to the extent the latter are assured that the world market is a reliable source of supply, both in periods of plenty and in periods of relative scarcity.

In addition, under the present aggregate minimum commitment of the Food Aid Convention, diverting food aid resources away from their prioritized use may seriously compromise the timely availability of resources for meeting pressing emergency needs as well as the needs of chronically food-insecure populations. The present Convention offers little room for providing any relief to countries facing difficulties from high food prices. It follows that serious consideration should be given in the renegotiation of the Convention to raising its aggregate minimum commitment.

Multilateral agencies have responded to past turmoil in both food and financial markets by establishing global safety-net schemes with the objective of assisting countries in financing food imports. These schemes have been valuable, but they were set up as crisis response measures and for a limited duration. As high and volatile prices look likely to continue, what is now required is a longer-term response, with emphasis on established market mechanisms. One approach, reliant on the purchase of call options, provides a promising way forward. This approach would enable vulnerable food importing countries to limit the impact of volatility in world food prices on their domestic markets and could be integrated with national food security structures. It would constitute a natural extension of trade-based policies recently advocated by multilateral donors. A structure through which multilateral agencies would intermediate optionality, such that costs and ownership remained with the countries themselves, would be appropriate. Taken together with an agreement to limit use restrictions on food exports, the market-based approach can re-establish food security on a trade basis and obviate the need for costly national food stockpiles.

The world, however, needs a greater understanding of the characteristics, role and possibilities of futures markets in today's globalized environment. A global contract with multiple delivery ports containing safeguards against "excessive speculation" and assurances of commercial viability could help remedy the current market shortcomings. A hybrid quote system of dollars, and say, Special Drawing Rights could prove to be an interesting test case for commodity pricing, and would assuage sharp currency-related price movements in markets.

The complexity of the new marketplace has placed exceptional demands on accurate and timely information on commodity developments and on the external drivers which influence market outcomes. It is argued that among the root causes of recent price volatility was the lack of reliable and up-to-date information on crop supply and demand and export availability. The problem is widespread. Despite the increase in the volume of raw data and the greater speed of transmitting information over recent years, the capacity to analyse the mass of often conflicting and variable-quality data and to disseminate the resulting analyses has not kept pace, particularly in the public, free-access sector. Furthermore, at the national level, the capacity of many countries to collect and process basic agricultural data has often deteriorated, and public statistical services have difficulties undertaking such forward-looking exercises as crop forecasts, let alone comprehensive supply/demand analyses and trade forecasts. More widely, traders' inability to give proper weight and context in processing new information may lead to an over- or under-reaction in price response. Therefore, a corollary of enhancing information provision in the public domain would be both to improve the efficiency of the price system as well as gearing-up countries towards impending turbulence.

Another issue that requires urgent addressing concerns biofuels, especially those derived from food staple crops. Expansion of biofuels that is unpredicted, or so rapid that it outpaces the ability of the economy to accommodate it, reduces carryover stocks of grains and oilseeds, raises food price levels and increases the threat of further price spikes in response to any unforeseen short-run disturbance. If, as is likely, these policies are maintained and even expanded, their worst effects might be mitigated by food security call option agreements. If designed carefully and implemented before a new, possibly much more serious, food price spike occurs, such contracts could facilitate a diversion of commodities away from energy use to maintain the consumption of vulnerable populations during times of scarcity. They might also help to reduce pressure on global prices when undertaken by wealthier countries with significant food or feed-based biofuels industries and thus mitigate price hikes. These options are not a universal solution to the food security challenge and the exact nature of such contracts and their implementation would need to be tailored to the needs of specific markets. Prudent humanitarian food policy would seek to mitigate the effects of such spikes to the well-being of poor grain consumers in affected developing countries, whether exporters or importers. "Diversion option contracts", triggered at a certain price level for grains used as biofuel feedstocks could be part of such a policy.

Countries themselves can do a great deal to shield food security given the prospect of turmoil. Part four devotes considerable attention towards operational guidance on establishing social safety nets, emergency reserves, self-targeting and other schemes to protect those most at risk. In view of the adage that "the best cure for high prices is high prices", similar guidelines on implementing "smart subsidies" to incentivize production and to improve supply response are also presented.

Recognition that food insecurity is, above all, a manifestation of poverty, this book concludes with a call for greater investment in agriculture. Around 75 percent of the poor live in rural areas and many depend on agriculture for their livelihoods. They eke out a living on farms of often less than two hectares, work as small entrepreneurs or earn meagre wages in the agriculture-related processing, storage, seed or feedstuffs sectors. They are poor because they rely on too few and too unproductive assets. A profound and prolonged lack of investment in agriculture has restrained the overall productivity of the sector, sometimes to the extent that it no longer stands as a viable base for poverty reduction. A lack of investment has also reduced the ability of farmers to cope with price volatility. Moreover, the cyclical tendency of investment flows appears to have pronounced price peaks and troughs.

Investment needs are assessed, instruments identified and financing possibilities sketched out in programme proposal to reach a world free of hunger by 2025. By setting an annual target, a feasible trajectory is cast for necessary action. A twin-track approach of affording vulnerable societies access to more productive resources and support by safety nets is presented in the programme. The programme also promotes the adoption of more sustainable production methods and investment in the conservation of natural resources, institutions, infrastructure and job creation in rural areas outside of agriculture. It invests in people and physical assets alike; it addresses both the need to raise output and productivity and the need to improve the sustainability of production methods. Furthermore, given the impossibility to sequence public investments counter-cyclically, the programme suggests that public investment should be allocated in equal instalments. If implemented, a natural corollary of the programme would be to lower the vulnerability of those most at risk from exogenous shocks, both weather-related and economic ones, especially those which lead to irreversible harm to societal systems and human capital.

A way forward

When global systems fail, it is improbable that the actions of individuals alone will provide the necessary resolve. A coherent and effective system of governance of food security at both national and international levels is warranted. Global governance is concerned with reaching consensus in optimal policy choices and policy coordination. Global governance has important implications for shaping a more stable market environment; for instilling greater confidence, predictability and assurance in markets; for guaranteeing access to food by low-income food-deficit countries and for better equipping governments to the challenges that lie in the wake.

The pressing issues emerging from this book that require governance at the global level are as follows:

Strengthening market signals for global price discovery: Commodity investment in organized exchanges has emerged as an integral part of the global food system. As an asset class, commodities that are key to food security, may be vulnerable to the behavioural dimensions of investors, whom on average as reflected by market outcomes, do not always fulfil rationality. Trading that pays little regard to market "fundamentals" can distort signals arising from these exchanges. Therefore, a challenge is how to enhance the price discovery function of international commodity exchanges. Clearly, trading behaviour that gives rise to excessive volatility does not contribute to this function. Furthermore, as with any financially traded asset, there is a need to ensure that commodities are accorded with the same level of jurisprudence and regulatory provisions across all commodity exchanges that are important for global price discovery and trade.

Introducing global grain contracts on exchanges: Large international exchanges could construct global contracts for grain and oilseed markets that would complement their current product offerings. Instead of tracking prices that converge with cash values in a single geographic area, global contracts could track "cheapest to deliver" commodities by designating delivery points all over the world.

Strengthening global market intelligence: An improved public global surveillance system on export availabilities and import demands would help temper uncertainty in organized markets that play a role in global price discovery. It would also enable countries to equip themselves better before the full impacts of crises transpire.

Ensure the supply and demand of grain-based bio-fuels are market compatible: Countries with support regimes for biofuels need to review such policies in the light of their impact on food security. As a market compatible instrument, call options with domestic biofuel producers could be introduced which would guarantee the mutually advantageous diversion of grain from biofuels production to enhance food security in crises.

Strengthening trade rules and making them symmetric for instilling greater confidence in global markets: crisis and turmoil at the global level can abruptly erode the confidence in market functioning. Liberalization will reallocate a country's exposure away from domestic shocks towards global shocks. For many governments, this was brought home to them in past episodes that found that reliance on trade for food security objectives is likely to fail in exactly those circumstances in which it is required. But global shocks will be significantly lessened if countries restrain from discretionary export bans and import restrictions.

Reform the Food Aid Convention: The present Convention provides insufficient scope in giving relief to countries that are vulnerable to episodes of high food prices. Consideration must be given by the FAC to raise aggregate minimum commitments during such episodes.

Enhance global safety nets: Reforms of financing facilities under existing institutions, could help vulnerable countries cope during times of crisis by providing global safety nets. These institutions need to act *ex ante* rather than *ex post*, e.g. by providing import financing or guarantees to alleviate the burden of credit and foreign exchange constraints that have afflicted countries' ability to meet food needs in past crisis.

At the national level, there is no single catchall solution for framing optimal policy design, for there exists substantial heterogeneity among countries in terms of their stage of economic development, dietary patterns, in agri-climatology, in geography (e.g. proximity to seaports) and net-trade statuses. Even within countries, the proportion of the population who are landless, the urban-rural composition of the population and expected changes to the ratio over time will also have an important influence on policy design. The challenges to be addressed if we are to build resilience and to protect the most vulnerable against global turmoil can nonetheless be generalized as follows:

Investment: Improving overall productivity of a diversified basket of food staples, supported by investments in research and development, infrastructure promoting irrigation and drought resilient crops and their hybrids through incentive frameworks.

Market completeness and institutional capacity to manage risk: Enhancing the role of financial institutions in providing smallholders with access to credit and instruments for managing risks.

Protection: Providing social safety nets for the most vulnerable, including emergency reserves and self-targeting schemes.

Futures and call options to manage risk: Strengthening and promoting market-based non-distortionary instruments to instil greater predictability in import expenditures. Exploring national call options for diverting value-added indigenous crops to food systems in emergencies.

Returning to the analogy between natural disasters and food crises, clearly any form of prevention is much costlier after a major disaster, than before it, but perceptions about the need for prevention are strongest only after a disaster not before it. It is this fundamental problem of "cognitive failure" that must be overcome at a global level if the world is to be assured of a governance structure that will avoid crises in food markets and ensure smooth flows of food to all.

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Part I

SETTING THE STAGE

Chapter 1

Why volatility matters

Adam Prakash[1]

Volatility represents the directionless variability of an economic variable, i.e. the dispersion of that variable within a given time horizon. For example, high (low) price volatility is described by situations when prices fluctuate significantly (little) over a short time period in either direction.

Popular discussion often confounds volatility with high prices. As a matter of logic, it is possible for prices to be high but show little variability, or to be low but variable. In practice, price levels and volatilities tend to be positively associated, in part because a low carryover from the past will reduce current availability, exerting upward price pressure, and will reduce the possibility of using inventory to meet positive demand or negative supply shocks, thereby increasing volatility (Gilbert & Morgan, 2010).[2] Typically, therefore, when prices are high they are also volatile.

Episodes of prolonged price volatility generate considerable uncertainty and affect vulnerability. They spawn increased risks in productive activities and undermine food security in developing nations. Persistent volatility can also have adverse macroeconomic consequences by obviating economic growth in commodity-dependent developing countries. More worrisome is that large negative shocks to welfare can lead to irreversibility, setting in motion a downward spiral of rising vulnerability while fragile coping mechanisms are diminished. Crisis and extreme volatility generate risk and asymmetry of impact, which, as witnessed in recent episodes, accentuates poverty, leads to malnutrition and increases political insecurity and the risk of internal conflict.

Concepts and definitions

Regular price fluctuations - "day-to-day" or "normal volatility" - is both typical and requisite for competitive market functioning. The essence of the price system is that when a commodity becomes scarce its price rises, thus inducing a fall in consumption and signalling more investment in the production of that commodity. It is important to know why prices have risen in order to counteract the scarcity appropriately (Grossman, 1976). However, the efficiency of the price system begins to break down when price movements become increasingly uncertain and precipitous, and ultimately reaches the point of redundancy when prices undergo "extreme volatility" - or "crisis" - to use popular terminology.

1 Statistics Division (FAO).

2 "Availability" is carryover from the previous crop year plus production in the current crop year.

Volatility may seem a rather obvious concept, but a precise definition is elusive and its measurement is prone to much subjectivity. In mainstream economic theory, however, volatility connotes two principal concepts: variability and uncertainty;[3] the former describing overall movement while the latter referring to unpredictable movement. As households and planning agencies are able to cope better with predictable variation, unpredictable changes - or "shocks" - are of primary concern. When shocks surpass a certain critical size or threshold and persist at those levels, traditional policy prescriptions and coping mechanisms are likely to fail (Wolf, 2005).

In addition to the distinction between normal and extreme volatility, price movements may be excessive relative to changes in "fundamentals" - i.e. shocks to demand and supply - over and above that which is predicted by the efficient market hypothesis (see Chapter 14) and is termed "excess volatility" (Shiller, 1981; LeRoy & Porter, 1981). Shiller takes the view that excess volatility is attributed to investors' psychological behaviour, by which substantial price changes are the outcome of a market-wide cognitive process that can only be explained by its thoughts and beliefs about future events.

As will be discussed in the following chapters, the challenge is not to eliminate volatility in its entirety, but rather to remove excess volatility (not necessarily in the Shiller sense). The challenge will also involve enhancing a country's ability to cope with extreme events, shielding food security (see Box 1.1) and equipping productive sectors to respond when called upon. Furthermore, events that trigger episodes of global volatility pose extreme covariate risks to all who are vulnerable. It is these events that present the greatest challenge to policy design.

Box 1.1: Defining food security

The concept of "food security" has been interpreted in many ways. An FAO report (FAO, 2003) notes that there are more than 200 interpretations of the concept. The report defines food security as follows:

> *Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within the household as the focus of concern.*

A cursory view of many regions in the world, however, reveals that no matter how one defines the concept, food security as a goal of assuring an individual's access to food and nutrition has not yet been realized to any significant extent. This reality has become obvious with the increasing use of and reliance on the term "food insecurity". Over the decades, the concept of food security has continued to evolve with new twists and turns in its meaning appearing every few years or so. These food security evolutions can be pictured metaphorically as an "artichoke". At the heart of the artichoke is the core of the concept of food security, that is, access to adequate nutrition for physical and mental well-being, which always remains the same, but over time different uses of the concept by different users (both individuals and organizations) in pursuit of a wide and varied range of variations on the food security theme to suit their goals and needs add layer upon layer of outer leaves to the centre of the artichoke.

Source: FAO (2009b).

[3] To be more precise, Knight (1921) distinguishes between uncertainty and risk on the basis of the probability distribution governing outcomes. Risk refers to uncertain events, where the distribution of outcomes is known. Uncertainty refers to events for which the distribution of outcomes is unknown and probabilities assigned to events cannot be assigned.

Exceptional shocks and volatility

The literature on commodity price shocks assumes that large and unexpected changes in prices have a disproportional impact on the economies that endure exceptional shocks, and that impacts are nonlinear, typically being asymmetric (Dehn et al., 2005). This arises because governments and households are well-adapted to normal volatility but neither anticipate nor consider making worthwhile provisions against extreme shocks, and assign low probability to the risk of such events. Dehn et al. propose two ways in which to distinguish between normal and exceptional shocks:

- view the largest α percent of shocks in the absolute value of the price change over time as being exceptional; or
- view shocks greater than an absolute specified size, ε, as being exceptional.

The authors note that there will be a quantity $\varepsilon(\alpha)$ that will make the two definitions equivalent. Using a value of $\alpha = 2.5\%$ and $\varepsilon = 1.96$ standard deviations, Dehn (2000) identifies a total of 278 shock episodes in a sample of 113 developing countries over the period 1957-97. This amounts to 2.5 exceptional shocks per country, or one every 16 years. Interestingly, the author finds shocks more prevalent in the latter years of the sample, with an incidence of one extreme event every nine years. Also, around two-thirds of these shocks were positive.

Attempting to quantify the exact magnitude of a shock that could propagate crisis is problematic and is subject to a degree of arbitrariness. Such an exercise must take *vulnerability* into account. A cursory look at the dictionary defines the term vulnerability as:

> *the degree to which people, property, resources, systems and cultural, economic, environmental and social activity is susceptible to harm, degradation, or destruction on being exposed to a hostile agent or factor.*

For instance, a one-time 10 percent increase in the price of rice may be comfortably absorbed by consumers in developed countries, but not so in many low-income countries.

Box 1.2: Defining food security vulnerability

Reviewing the notions of vulnerability used in the literature reveals many different concepts depending on the specific application, whether in economics, sustainable livelihood, food security, sociology/anthropology, disaster management, the environment, or health/nutrition sciences (see Alwang et al., 2000). The main tension seems to be between conceptual and empirical strength. No concept employed so far seems to account for/contain both.

In its simplest form, food vulnerability for an individual or household can be measured as the probability that expected future consumption will fall below some minimum level. For a household at time t, let c_{ht} denote per capita consumption expenditure and let $\bar{c}$ denote the poverty line. Then, vulnerability, v_{ht} is the probability that the expected per capita consumption is below the selected poverty line, with an arbitrarily chosen probability threshold $\bar{P}r$ (of, say, 0. 25 or 50 percent):

$$v_{ht} = Pr(c_{ht\pm 1} \leq \bar{c}) \geq \bar{P}r \qquad (1)$$

To make this definition operational, a particular income-generating process is assumed for household consumption. This requires knowledge of the determinants of household consumption. A household's consumption in any period will depend on a number of factors including its assets, current income, and expected future income (i.e. permanent income). Cases of liquidity constraints or low permanent income will significantly impact future consumption levels and their volatility.

Source: Holzmann (2001).

Consequently, a better approach to characterize extreme volatility and crisis refers to the shock's likelihood to overwhelm a country's *ability* to dampen the shock or to mitigate its impact. "Ability" here is related to a country's degree of vulnerability.

Research has shown that extreme price volatility tends to lower investment in physical capital, human capital and also research and development (Jacks et al., 2009). The repercussions from sustained and/or exceptional shocks are attributable to two factors: first, the uncertainty they generate and the increased risks in productive activities; and second, the *irreversibility* of some of the effects.

Accordingly, when a shock leads to a loss of physical and long-run human capital, poverty traps may result. Diminished income in already low-income countries can result in malnutrition, mortality, withdrawal of children from education and sustained high unemployment. Irreversibility, in this regard, is a critical concern for policy-makers, as it can set forth a vicious downward spiral of increasing vulnerability as fragile coping mechanisms are eroded.

Measuring volatility

Chapter 2 catalogues the statistical and theoretical properties of volatility, including measurement issues. Briefly, volatility *per se* is typically measured based on the standard deviations of an observed (random) variable over a chosen history. A recurring formula in the literature (especially applied in finance) is the following:

$$\sigma = \sqrt{\sum_{i=1}^{n} [r_t - \mu]^2 / n - 1} \qquad (2)$$

where σ is the standard deviation, r_t are the logarithmic returns[4] on prices P_t: $r_t = ln(P_t) - ln(P_{t-1})$ and μ is the average return, and n is the number of sample observations. Often, volatility is described in annualized terms, derived through multiplying the square root of time, $1/\sqrt{T}$, where T represents the frequency of the observation (e.g. daily, monthly, etc.).

Volatility measured in this manner is referred to as annualized *realized* or *historical volatility*. Seeing as many economic series contain trends, measuring volatility requires the series to be de-trended;[5] otherwise trend fluctuations will be accounted for in the volatility measures. Moreover, because such trends are often stochastic, de-trending requires a trend model that implies a judgemental trade-off between attribution of variability to the trend itself and to variation about the trend, hence the volatility measure will be prone to model-dependence in the choice of the trend (Gilbert & Morgan, 2010). It is for this reason that standard deviations of (logarithmic) price differences or returns are widely used to measure realized volatility.[6]

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4 Logarithmic returns represent continuously compounded returns, which can produce asymmetries in the balance of returns when compared with simple percentage returns. For example, a 10 percent return results in 9.53 percent continuously compounded return, while an equal negative results in a continuously compounded return of -10.53 percent.

5 For seasonal series, pre-filtering would be required.

6 Researchers also typically concentrate on the standard deviation of logarithmic prices as this is a unit-free measure. It can be shown that for low levels of volatility, the logarithmic standard deviation is approximately equal to the coefficient of variation.

Following this approach, Figures 1.1 and 1.2 plot real price levels and their respective historical volatility for a number of food commodities. It is seen that real historical cereal and oilseed price volatility has been rising over the past 50 years, a characteristic not shared by most other commodities. For instance, relative to the recent past, volatility in vegetable oil, livestock, sugar and beverage prices has generally fallen (though from very high absolute levels for the latter two product groups).

Notwithstanding the perils of drawing inferences from visual inspection of the data, understanding whether or not realized volatility has fallen or risen is not an issue of concern here. Instead, it is uncertainty and forward looking that are key. Realized volatility is backward-looking as its measure is based on past price movements after the resolution of supply and demand factors. But economic agents base their decision-making on expected variables such as future prices and the uncertainty about them, and not solely on their realized values.

Ramey & Ramey (1995) and Serven (1998) attach critical importance to the volatility-uncertainty distinction. Basically, uncertainty affects the decision-making of economic agents, while volatility - or total variability - is important to the extent that agents cannot smooth consumption, reflecting either unwillingness or an inability. It is important to note that if components in the variable of interest are deterministic and hence predictable, then uncertainty may be overstated.

Measuring uncertainty is particularly complicated, as it predominantly rests on a subjective choice of model that must capture perceptions about what is predictable about volatility and what is not. Dehn et al. (2005) highlight this complexity:

1. If prices and volatility are both unpredictable, then certainty is indistinguishable from uncertainty. In this case, realized volatility based on the most recent history would constitute the best available estimate for future volatility.
2. If prices are subject to mean reversion in that prices return to some fundamental or long-run equilibrium level value, e.g. the marginal cost of production, then prices may be partially predictable. If price trajectories are determined in this manner, but volatility is unpredictable, then uncertainty is measured by the volatility in the price innovations and not by prices themselves. For this reason, the residuals from some forecasting equation (e.g. error terms from an ordinary least squares regression) are often used in measurement.
3. If changes in price are not constant over time, in that they persist or cluster, then volatility may be predictable (e.g. through an Autoregressive Conditional Heteroscedastic (ARCH)) specification - see Chapter 2). Uncertainty in this instance is time-varying, and may be greater than volatility at any interval.

When components are predictable, such as in (1) and (2), then measuring uncertainty will be subject to the choice of model. Selecting a model that best approximates the phenomenon to be examined is a difficult task, given the host of models at the researcher's disposal. In fact, a whole body of econometrics is concerned with the study of methods for model selection.

So far, reference to volatility has been made in the context of *realized* volatility and conditional measures in the modelling of uncertainty. The data upon which realized and conditional volatility is calculated may no longer reflect the prevailing or expected supply and demand situation. There is, however, an objective metric available that focuses inherently on market-wide uncertainty. Being responsive to prevailing and future market conditions, *implied* volatility signals the market's *expectation* of how commodity prices might evolve.[7]

[7] If investors have a rational expectation of volatility, implied volatility would be an unbiased proxy for historical or realized volatility of the same period based on the measures (1)-(3) above. In other words, the expectation of future volatility can fluctuate around, but not consistently move in, one direction away from historical volatility (Wang, 2009).

Box 1.3: Measuring implied volatility

Implied volatility represents the market's expectation of how much the price of a commodity is likely to move in the future. It is called "implied" because, by dealing with future events, it cannot be observed and can only be inferred from the prices of derivative contracts such as "options".

An "option" gives the bearer the right to sell a commodity (put option) or buy a commodity (call option) at a specified price for a specified future delivery date (see Chapters 19 and 20). Options are just like any other financial instrument, such as futures contracts, and are priced based on market estimates of future prices as well as on the uncertainty surrounding these estimates. They are subject to the law of supply and demand. Hence, any excess or deficit of demand would suggest that traders have different expectations of the future price of the underlying commodity. The more divergent are traders' expectations about future prices, the higher the underlying uncertainty and hence the implied volatility of the commodity.

Does implied volatility matter? Prices that are observed today for commodities traded in the major global exchanges are influenced by the sentiment captured by implied volatility. When these markets are efficient, they convey all known information, future and the present, pertinent to the market and the commodity. Hence, implied volatility as a metric is an important instrument used in the price discovery process and as a barometer for where markets might be headed.

Implied volatilities for several major internationally traded foodstuffs are presented in Figure 1.3. In the last month of 2010, implied volatility stood at 36, 35 and 28 percent for wheat, maize and soybeans respectively. As implied volatility is measured as a percentage of the deviation in the futures price (six months ahead) from underlying expected value, under reasonable assumptions (price changes are drawn from a normal distribution) one can say the market estimates with *68 percent certainty* that prices will change by 36 percent for wheat, 35 percent for maize and 28 percent for soybeans.

In a similar vein, the likelihood that prices will exceed their current values by more than 50 percent in six months is perceived to have a probability of around 2 percent, in other words quite unlikely. This is not to say that such events will not take place. The surge in maize prices in September 2006 that set the stage for that particular episode surprised the markets. Although traders were betting on higher prices, they handed only a 5 percent chance for a 50 percent or more increase in the price of maize in six months. Instead, prices actually climbed by almost 60 percent in that period. Implied volatility can be a useful metric in revealing how traders expect prices to develop, but it also exposes just how wrong expectations can be.

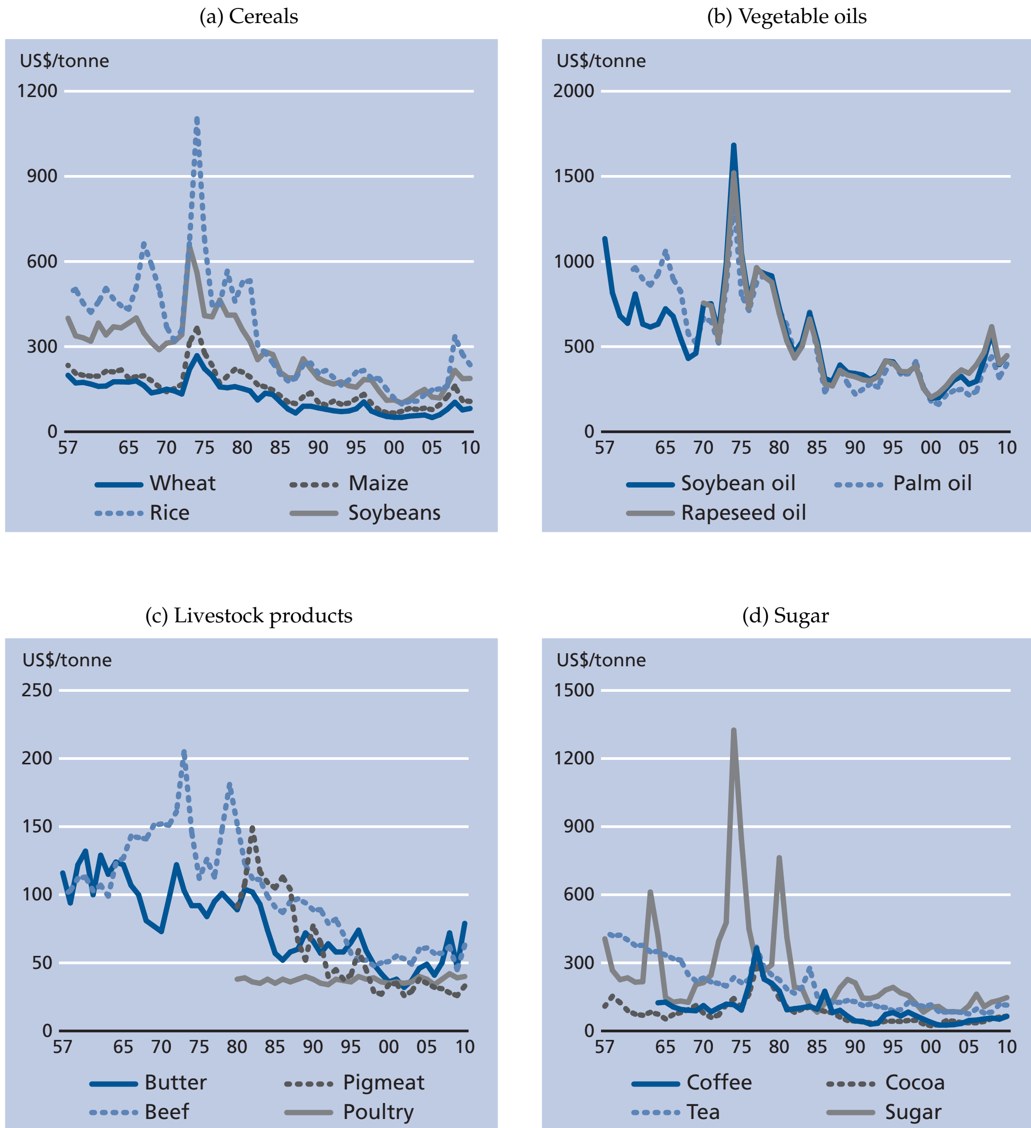
The large upswings in implied volatilities that have recently been witnessed bear testament to the enormous uncertainty that markets face in predicting how agricultural commodity prices may evolve in the future. There appears to be irrefutable evidence of a secular rise in uncertainty for traded commodities key to food security.

Social and economic costs of volatility

Episodes of high prices and extreme volatility are a major threat to food security in developing countries. Their impact falls heaviest on the poor, who may spend well over 80 percent of their income on food (see Figure 1.4). The lack of dietary diversification aggravates the problem, as price increases in one staple cannot easily be compensated by a switch to other foods.

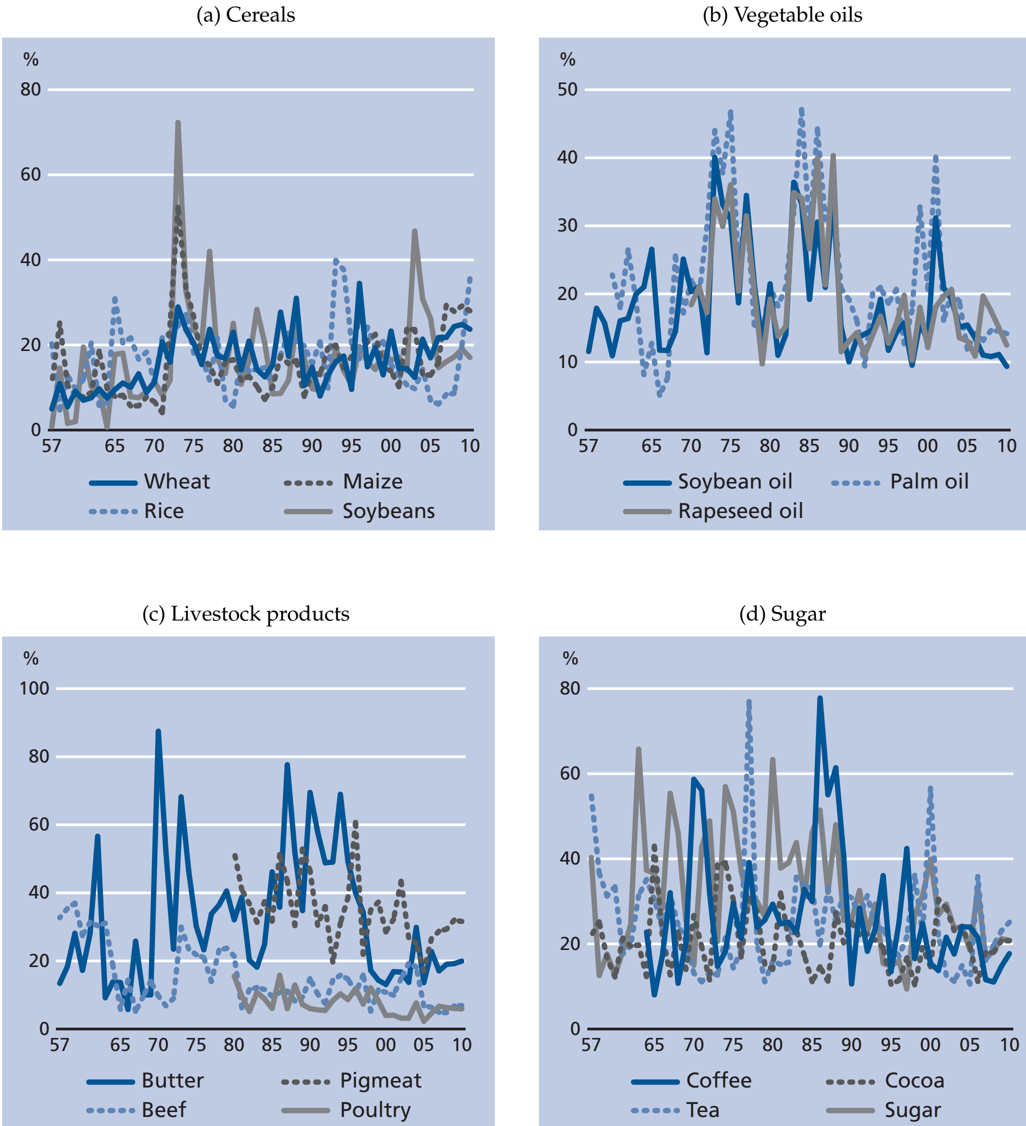
Coping with high food prices poses extreme adjustment costs that undermine food and nutritional food security. Figure 1.5 illustrates possible household response options and

Figure 1.1: Annual real prices of selected foodstuffs: 1957-2010



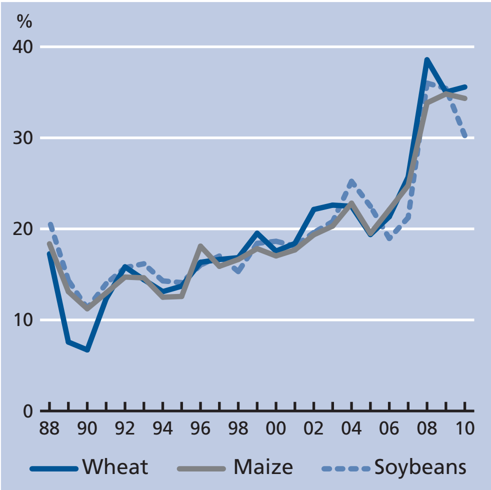
Note: Real prices refer to nominal prices adjusted for changes in US Producer Price Index (2000 = 100). Sources: Cocoa (ICCO); coffee (ICO); cotton (COTLOOK A Index 1-3/32"); maize (US No. 2, yellow, US Gulf); rice (white rice, Thai 100% B second grade, f.o.b. Bangkok); soybeans (US No. 1, yellow, US Gulf); sugar (ISA); tea (total tea, Mombasa auction prices); Wheat (US No. 2, soft red winter wheat, US Gulf); beef (Argentina, frozen beef cuts, export unit value); butter (Oceania, indicative export prices, f.o.b.); pig meat (United States of America, pork, frozen product, export unit value); poultry meat (United States of America, broiler cuts, export unit value); rape oil (Dutch, f.o.b. ex-mill); Soya oil (f.o.b. ex-mill).

Figure 1.2: Annualized real historical volatility of selected foodstuffs: 1957-2010



Note: Real prices refer to nominal prices adjusted for changes in US Producer Price Index (2000 = 100). Sources: Cocoa (ICCO); coffee (ICO); cotton (COTLOOK A Index 1-3/32"); maize (US No. 2, yellow, US Gulf); rice (white rice, Thai 100% B second grade, f.o.b. Bangkok); soybeans (US No. 1, yellow, US Gulf); sugar (ISA); tea (total tea, Mombasa auction prices); Wheat (US No. 2, soft red winter wheat, US Gulf); beef (Argentina, frozen beef cuts, export unit value); butter (Oceania, indicative export prices, f.o.b.); pig meat (United States of America, pork, frozen product, export unit value); poultry meat (United States of America, broiler cuts, export unit value); rape oil (Dutch, f.o.b. ex-mill); Soya oil (f.o.b. ex-mill).

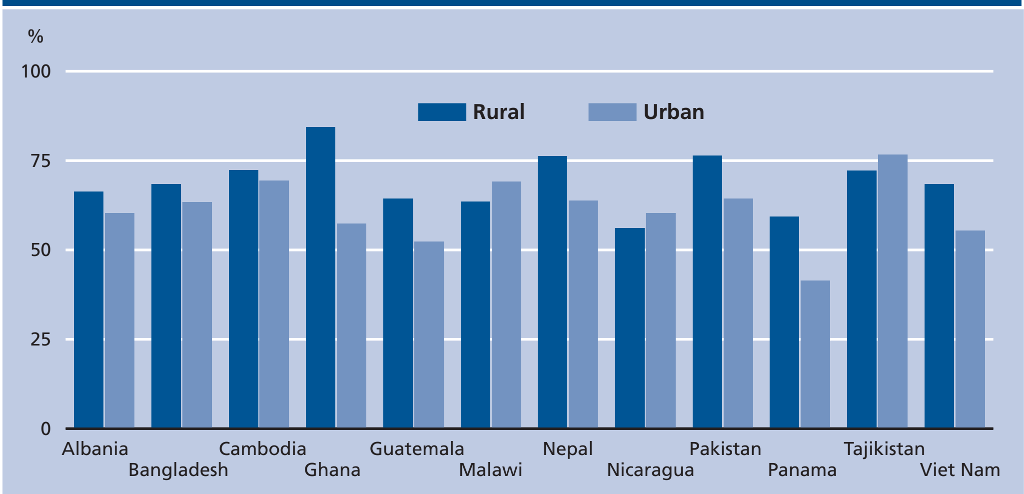
Figure 1.3: Implied volatilities: 1987-2010



The Black-Scholes model is used to compute implied volatilities from Chicago Board of Trade underlying data. Key inputs and assumptions are as follows: (i) six-month time expiration on contracts; (ii) settlement premium for the call options "at the money", i.e. with a strike price nearest to the settlement price for the futures contract associated with the call option contract (mid-monthly prices were used); (iii) option strike price; (iv) futures settlement price; and (v) six-month US treasury bill yields which are assumed as the risk-free rate.

Source: CME, FAO.

Figure 1.4: Shares of income in poorest households spent on food in selected developing countries

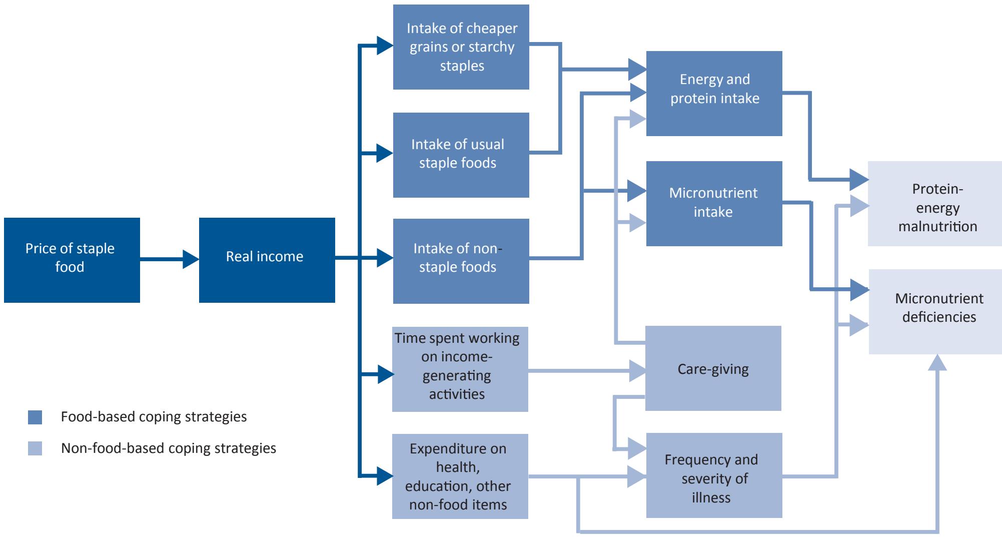


Source: Davis et al. (2007).

the impact that various food-based and non-food based coping strategies may have on the nutritional status of individuals.

Among the food-based coping strategies, a sudden loss in purchasing power may result in changes in the quantity, quality and/or diversity of food items consumed. In countries where people have access to a more diversified diet, households will respond to a sudden and dramatic increase in food prices by first reducing the number of foods consumed

Figure 1.5: Household coping behaviour and nutrition impacts following a sudden rise in food prices



Source: FAO (2008).

from different food groups while leaving overall consumption of staples unchanged. But, low-income households with little or no choice to reduce the diversity of their diets will predominantly respond by simply eating fewer meals per day and reducing non-food expenditure.

Non-food based coping strategies may involve a reduction in expenditure on health care and education, in addition to seeking other sources of income to offset the loss in purchasing power. Households may attempt to engage in new income-generating activities. Time constraints among women with small children may have negative health and nutrition-related consequences for children. Increased female employment may lead to less or lower-quality child care at home; it may interfere with breastfeeding, home-based food preparation, sanitation practices and seeking medical assistance when children are sick. Older siblings may have to take over from mothers in providing childcare though they are less equipped to do so. Increased child labour at home or outside may have further negative nutritional consequences and interfere with children's education.

The recurring issue of poor dietary diversification in staple foodstuffs is an important determinant on the impact of food price volatility on households. The dominance of a particular foodstuff in diets limits the potential to shift to other staples using trade as a means to moderate volatility in prices. The lack of dietary diversification is also the single most important variable influencing vulnerability (as well as political sensitivity) to unstable food prices, as when consumption is highly concentrated on one staple, the implication is that the staple makes up a large share of consumer expenditures (World Bank, 2005). Evidence of the lack of dietary diversification in vulnerable countries is illustrated in Figure 1.6, where it is seen that over one-third of all Low-Income-Food-Deficit Countries (LIFDCs) have a Herfindahl concentration index of 0.5 and above.

Box 1.4: Dimensions of consumer vulnerability: food security in sub-Saharan Africa during the 2006-08 episode

Research carried out by FAO examined the impact of food price increases on consumption, food expenditure and food security in Eastern and Southern Africa. Maize is the most important staple in these regions. For example, the annual per capita consumption of maize in Malawi amounts to about 130 to 160 kg, while that in Zambia ranges between 120 and 150 kg. The analysis suggests that an average household facing a 50 percent increase in the price of grains would reduce maize consumption by 8.5 and 15.6 percent in Malawi and Zambia, respectively. Poor and food-insecure households were found to reduce maize consumption to a lesser extent as compared with this average, reflecting that the poor have limited possibilities for substitution.

The analysis also suggests that in spite of the reduction in maize consumption, household food expenditure increases as prices soar. On average, household expenditure in Malawi was found to increase by 9.7 percent, as the 8.5 percent decrease in maize consumption did not suffice in keeping total food expenditures low. For the poor households that allocate approximately 33 percent of total food expenditure to maize, food expenditure was estimated to increase by 16 percent. In poor, female-headed households where food expenditure is characterized by a high share of maize, approximately 43 percent was found to experience significant increases in food costs. In Zambia, similar price increases were found to result in an increase of 8 percent in average household food expenditure. Nevertheless, as poor households in Zambia allocate about 20 percent of their food budget to maize, a 50 percent increase in grain prices was found to result in an 8.6 percent increase in total food expenditure.

High food prices and increased food expenditure imply decreases in purchasing power, leading to more households falling into poverty and becoming food insecure. The analysis suggests that in Zambia, a 50 percent increase in grain prices could result in a 5.4 percent increase in the number of food-insecure households. The corresponding increase in the number of food-insecure in Malawi was found to be significantly larger, reaching estimates of nearly 16 percent owing to the higher share of maize in food consumption and expenditure.

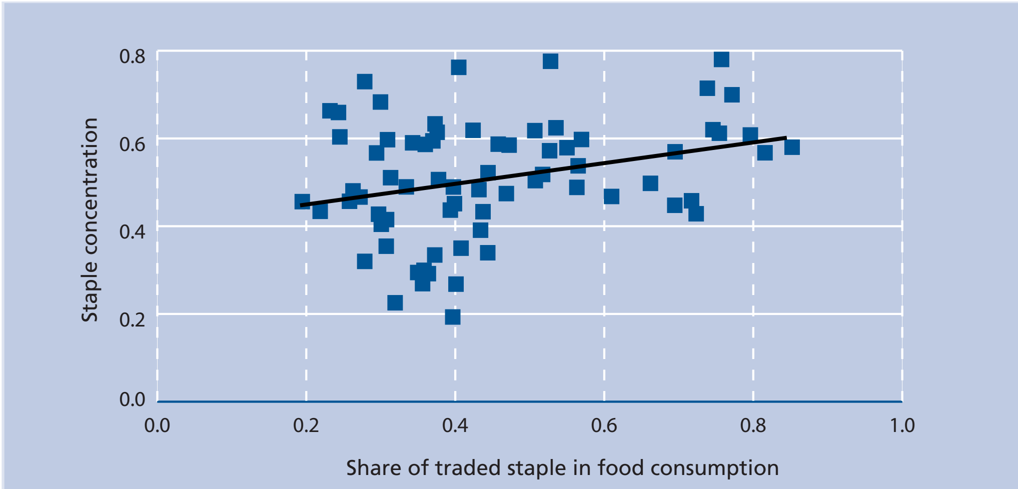
Staple dietary diversification is important in determining the impact of food price volatility on households. In Uganda, maize consumption amounts to an average of 29 kg per capita, a quantity significantly lower than that consumed in other countries in the region. Ugandan households consume a variety of staple foods such as rice, millet, matooke and cassava. Although the prices of rice and millet also rose, the prices of matooke and cassava roots (neither of which are internationally traded) exhibited weaker increases of about 35 and 20 percent respectively as compared with an increase of 75 percent in the price of maize. Wide staple diet diversification and the large quantities of domestically-produced staples consumed significantly moderated the negative impact of the international price surge on Ugandan households. FAO's analysis suggests that a 50 percent increase in the price of grains could result in an increase of 2.5 percent in the number of food-insecure households, an impact significantly smaller than that experienced by other countries in the region.

Evidence regarding the behaviour of rural households during the recent price surge is sparse. In Kenya, an examination of households' responses suggested that approximately 38 percent experienced a food deficit and resorted to various coping strategies. These included selling livestock, seeking farm and non-farm employment, decreasing the purchase of agricultural inputs and disinvesting in human capital.

These coping strategies affect future production and income streams. Delays in the payment of school fees and reduction in health care were also found to be common responses, suggesting that price upswings can cause irreversible impact on human capital.

Source: FAO (2009a).

Figure 1.6: Staple concentration and the share of traded staple in LIFDC diets (2007 data)



Note: The Herfindahl index, H is calculated as $H = \sum_{i=1}^{N} S_i^2$ where S_i is the consumption share of the starchy staple i in diets and N is the number of staples consumed. For a single staple consumed, the index would equate to one and declines as the staple base becomes more diversified. Source: FAO.

In addition, the main staples for most diets are, in large part, subject to global trade (e.g. rice in Bangladesh, Lao People's Democratic Republic and Myanmar; wheat in Azerbaijan, Tajikistan, Turkmenistan and Uzbekistan). Consequently, consumption expenditures are potentially vulnerable to international price rises.

As a further sign of vulnerability in food security, Figure **??** shows the tendency towards a positive relationship between the contribution of staples in overall diets and the dependence on a single-traded staple. This again confirms country-level evidence that international price fluctuations can have a direct consequence on consumption levels.

For farmers, who are highly dependent on commodities for their livelihoods, extreme volatility can result in large income fluctuations for which they have little or no recourse to the mechanisms that assure safeguards, such as savings and insurance. The delay between production decisions and actual production creates additional risks, as farmers base their investment and planning on expected prices.

Sandmo (1971) shows that uncertainty in output prices can give rise to firms employing fewer inputs and foregoing expected profits in order to hedge against price volatility. Since this seminal study, and another by Newbery & Stiglitz (1981), it is now commonly understood that producers (whose primary source of income is from agriculture) will prefer certainty in income generation to uncertainty with the same expected value.

Supply response to price uncertainty will therefore depend upon the degree of producers' risk aversion. Under increasing price volatility, supply will be reduced if risk aversion is moderate, but will be increased if risk aversion is high, as farmers are required to do more in order to cope with extreme events (Subervie, 2008). Consequently, the response of farmers to volatility depends on their degree of risk aversion. However, in a more dynamic setting, the expected supply response is more likely to be lower, with price volatility discouraging investment and innovation having a more uncertain return.

But the stakes are higher. There is extensive literature on the linkages between commodity price volatility and economic growth. The magnitude and persistence of a shock can lead to severe economic disruption. An extreme shock is often much more severe than a minor one seeing as credit and fiscal constraints or the exhaustion of a finite buffer reserve can produce chain effects. For example, a LIFDC may be able to cope with a one-time terms-of-trade[8] shock of, say, 10 percent, but if the terms-of-trade does not subsequently recover and the shock persists, the capacity of the country to cope may be exhausted.[9] Generally, a low degree of diversification and greater specialization in more volatile activities yields more volatile terms-of-trade, which is a major source of the overall economic instability which poor countries face (Jacks et al., 2009).

In reality, many of the least developed countries are net importers of food products, either in raw or processed form. For these nations, the proportion of the import bill that goes to food is generally much higher than in richer countries.

Figures 1.8 and 1.9 shows the burden of food import bills faced by economically vulnerable groups of countries in contrast with the developed group of nations. Imported food expenditures have been rising globally, reaching USD 1 trillion dollars in nominal terms in 2008 and in 2010 (FAO, 2010). Even in real terms, expenditures have escalated alarmingly. This situation could lead to increased stress if income growth and export earnings to sustain food imports are not adequate and/or if growth in imports undermines otherwise viable domestic production (i.e. owing to low international prices).

In order to put these developments into a perspective that would allow such an assessment to be made, Figure 1.8 presents the shares of total food import bills in GDP (Gross Domestic Product) and total merchandise imports, while Figure 1.9 shows the strain of importing against current account deficits that are both rife and persistent in the most economically vulnerable group of countries.

A clear picture emerges: while the rate of growth in food import bills has matched income growth for both groups of countries (in that the share of these bills as a percentage of GDP remains little changed) food import costs since the 2006-08 event account for a much higher share of total merchandise imports, reversing the positive trend of the previous decade.

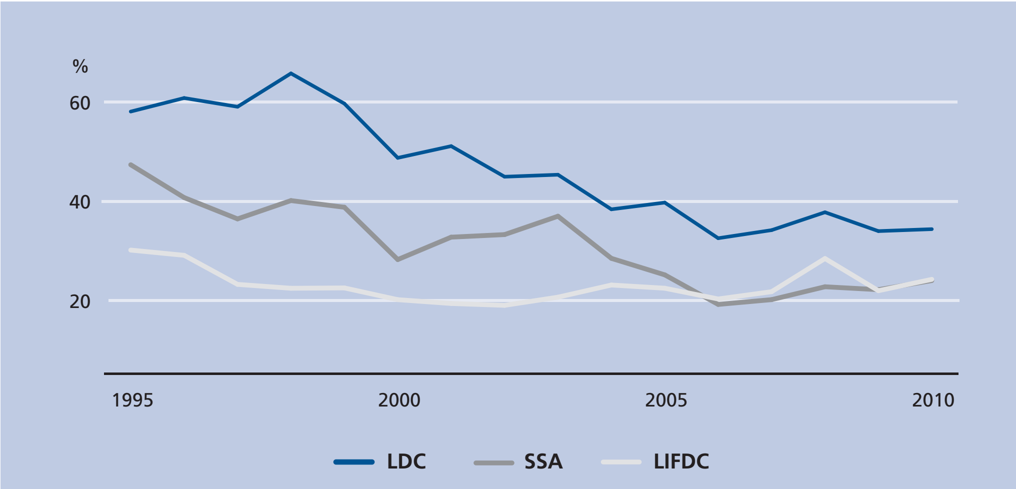
A price-induced rise in food import bills can place a severe burden on the balance of payments to meet food needs, depriving disadvantaged countries of limited foreign exchange reserves that could finance other essential goods and services, such as energy and inputs. High international prices and volatility also create a significant hurdle in planning and financing imports given sovereign credit ceilings. These trends and outcomes are by in large a stark contrast to those in developed countries.

The capacity of vulnerable countries to achieve basic food security from world markets exposes them to shocks originating externally. Figure 1.7 shows the value of cereal food imports as a share of foreign exchange reserves in vulnerable groups of countries. The gains from falling shares of foreign exchange reserves to meet imports began to stall during the 2006-08 episode, and has in some cases gone into reverse.

8 At the simplest level, "terms-of-trade" is the price of exports relative to the price of imports.

9 The country's exchange rate regime affects its ability to absorb fluctuations in their terms-of-trade. According to theory, a country faced with volatility in the terms-of-trade will be able to dampen movements under a flexible exchange rate with little impact on economic activity by contrast to a country with a fixed exchange rate regime.

Figure 1.7: Share of foreign exchange reserves to meet cereal import bills: 1995-2010



Source: IMF, FAO.

Quantifying the costs of volatility

In the modern policy era, welfare costs and the impetus to intervene have been framed in the context of how changes in aggregate economic activity, induced for example by volatile output prices, affects consumption or specifically, the quantity of foregone consumption. Much of this thought and ensuing policy design is owing to the Nobel laureate Robert Lucas, who proposed a simplified framework to assess the welfare cost of volatility, which has since been termed Lucas' formula (Lucas, 1987). Lucas gained prominence by challenging the foundations of macroeconomic thought and subsequent policy formulation by vehemently arguing that macroeconomic models should be conceived as an aggregate of microeconomic models. His findings have shifted the policy agenda away from economic stabilization to measures that sustain long-term economic growth.

To begin, assume the utility, U, of an economic agent over an infinite horizon can be depicted by the sum of the present value of utility derived from consumption c in each period t, discounted by the factor β:

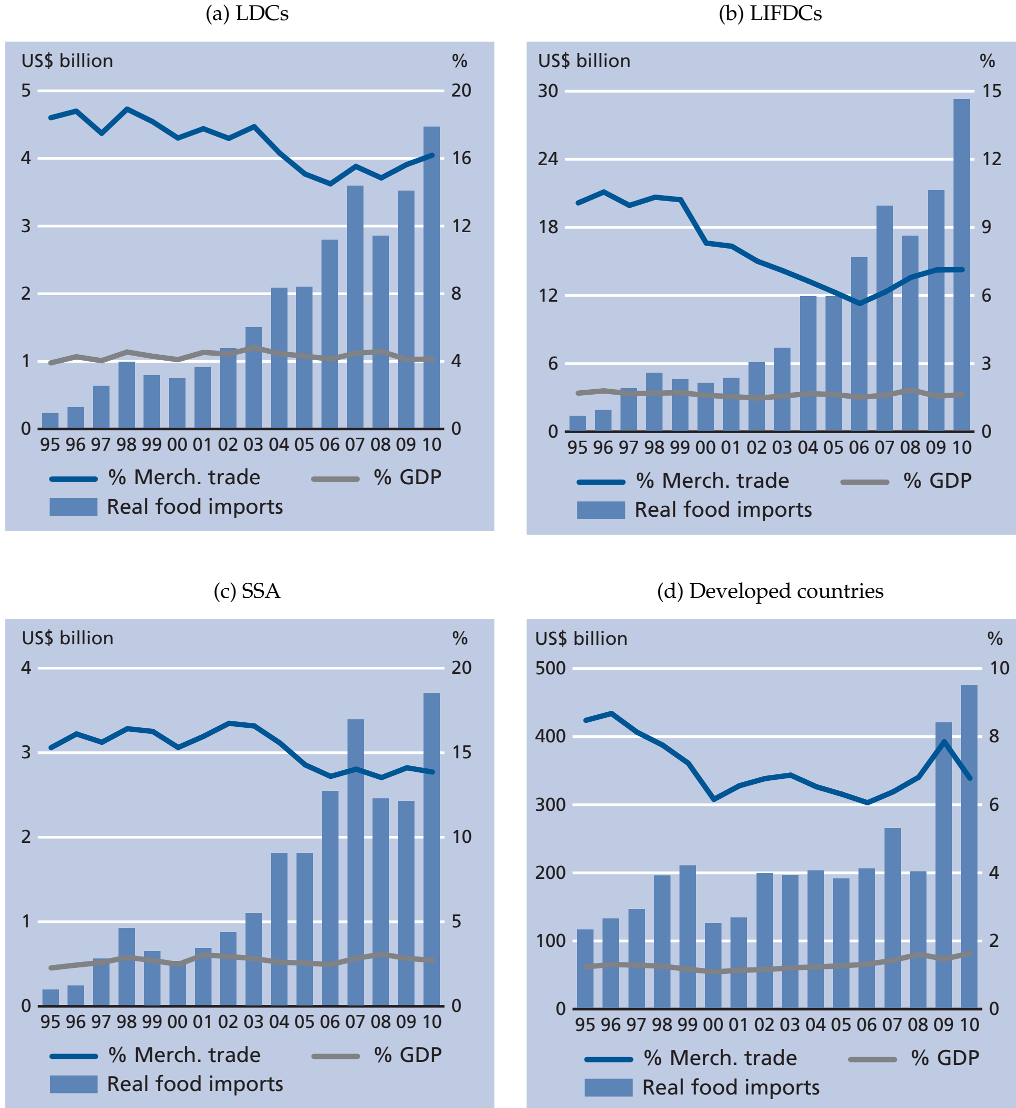
$$U = \sum_{t=0}^{8} \beta^t u(c_t) \tag{3}$$

The agent's utility is assumed to be risk-averse, such that $u(c_t) = \frac{c_t^{1-\gamma}-1}{1-\gamma}$, where γ is the degree of risk-aversion. In the absence of volatility, consumption is a smooth process governed by:

$$c_t^s = Ae^{gt} \tag{4}$$

where A is the base level consumption and γ is the rate of consumption growth. In the presence of volatility, however, consumption in each period is determined by the stochastic

Figure 1.8: The burden of importing food: 1995-2010 (a)



Source: IMF, FAO.

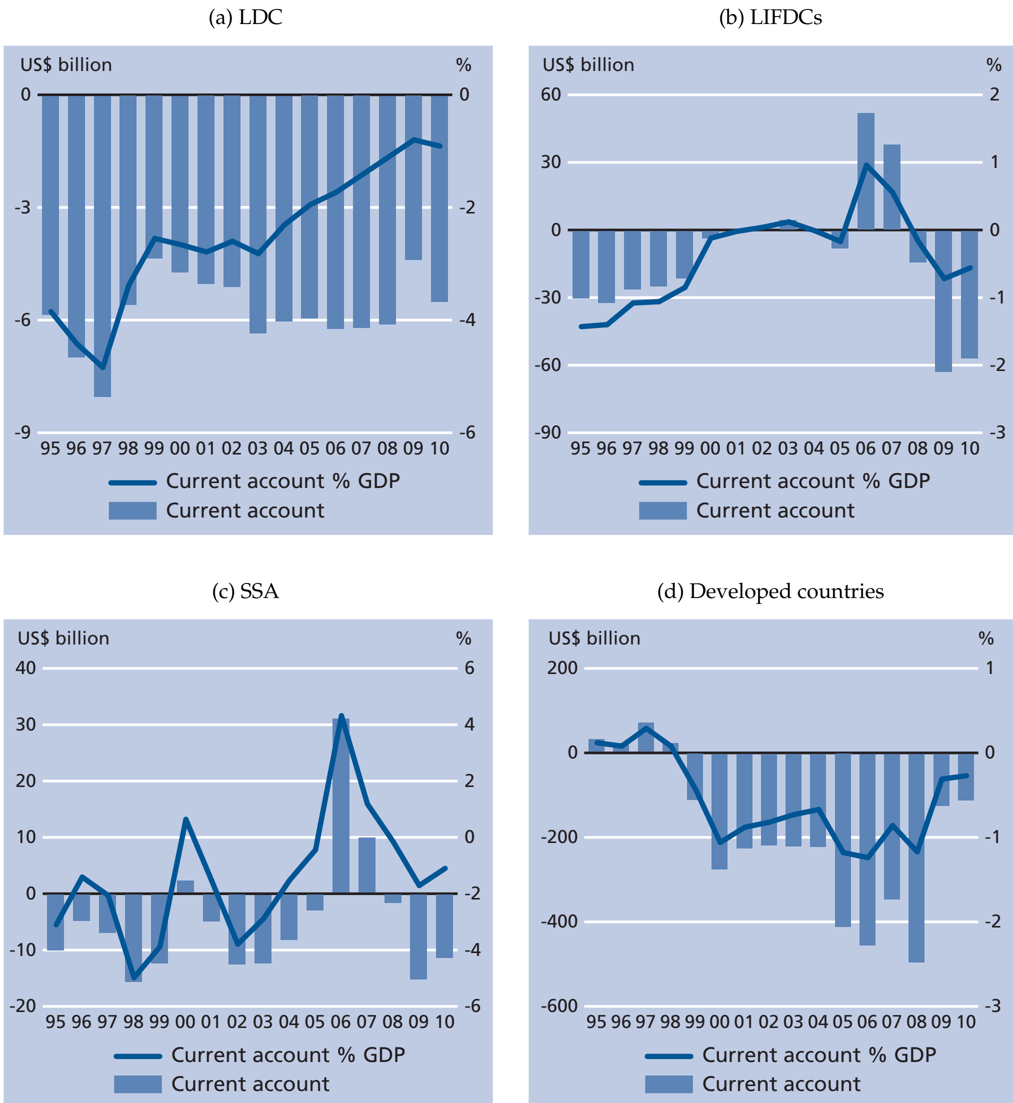
stream, which arises from stochastic prices confronting consumers:[10]

$$c_t^v = Ae^{gt}e^{-0.5\sigma^2}\varepsilon_t \tag{5}$$

with σ^2 being the variance of the natural log of consumption and ε is an innovation where

[10] The consumption stream is stochastic on the basis that prices are stochastic.

Figure 1.9: The burden of importing food: 1995-2010 (b)



Source: IMF, FAO.

$\ln(\varepsilon_t) \sim N(0,\sigma^2)$. Taking expectations, the stochastic component reduces to $E\left(e^{-0.5\sigma^2}\varepsilon_t\right) = 1$, so that on average, trend consumption under volatility mirrors that under certainty.

By maintaining the same mean level of consumption over the horizon, the risk-averse economic agent would choose a stable path over a volatile one where consumption increases (decreases) in periods of low (high) prices relative to incomes. The difference in utility can be measured by multiplying the volatile path by a constant factor $1+\lambda$ with the value of λ chosen to compensate all agents in terms of additional consumption, uniform across time and different shocks, so that they will be indifferent between the smooth and fluctuating consumption paths (Imrohoroglu, 2008).

To solve for λ, two different consumption paths (2) and (3) are equated through (1):

$$\sum_{t=0}^{\infty}\beta^t u\left(c_t^s\right)=\sum_{t=0}^{\infty}\beta^t u\left(c_t^v\right) \tag{6}$$

$$\sum_{t=0}^{\infty}\beta^t\left(\frac{\left(Ae^{gt}\right)^{1-\gamma}}{1-\gamma}\right)=\sum_{t=0}^{\infty}\beta^t\frac{\left((1+\lambda)Ae^{gt}e^{-0.5\sigma^2}\varepsilon_t\right)^{1-\gamma}}{1-\gamma} \tag{7}$$

Taking logs and simplifying yields:

$$\lambda\cong 0.5\gamma\sigma^2 \tag{8}$$

The compensation parameter λ constitutes the welfare gain from eliminating consumption risk, and depends, naturally enough, on the amount of risk that is present, σ^2, and the aversion people have for this risk γ (Lucas, 2003). The results are even more lucid if utility is logarithmic such that $u(c_t)=ln(c_t)$ which corresponds to the case of $\gamma=1$, so that $\lambda\cong 0.5\sigma^2$ That is, the welfare cost of volatility is roughly equal to one-half the variance of the natural logarithm of consumption, or simply put, a number so small that it trivializes the benefits of consumption derived through stability.

In an empirical example, Lucas (2003) examines the log of real per capita consumption data in the United States over the period 1947-2001. He finds the standard deviation of consumption changes around a linear trend to be in the order of 0.032. Assuming different degrees of relative risk aversion commonly observed in the literature, ranging from one to four in magnitude, the welfare cost of volatility varies between one-twentieth of 1 percent to one- or two-tenths of a percent of consumption. Just as the welfare cost of volatility is seemingly negligible in an absolute sense, it is also the case when compared with the welfare costs of other dimensions of the economy. For example, Lucas (2003) determined that the welfare cost of a 1 percent decline in the economy's annual growth rate could amount as much as 20 percent of yearly consumption, and when the welfare loss of inflation reaches 10 percent the result could be a total cost of around 1 percent of annual income. Both estimates are of a much higher magnitude compared with the welfare cost of economic volatility. Lucas has repeatedly argued that one must take seriously the estimated findings for the size of potential gains when designing policies that would eliminate fluctuations in economic activity. Taking these results seriously is exactly what the profession has done (Imrohoroglu, 2008).

Studies have also shown that volatility-reducing policies would be an impediment to increased profit streams and higher investment for competitive firms with full access to capital markets. Assuming that the area of the producer surplus is a quadratic function of the price facing firms, Aizeman & Pinto (2005) show that the profit function is convex with respect to the price of the output, and so higher price volatility would yield higher profits. Such messages attesting to the redundancy of stabilization policies would seemingly be welcomed by firms.

Lucas' formula, however, remains the subject of intense controversy in the more than two decades since it first appeared. Many economists have challenged its conclusions either by assuming more complexity in risk preferences, or by bringing more empirical realism into the framework (i.e. the functional form of utility, hence γ and also the stochastic nature of σ.

The wider environment in which agents confront volatility also matters, as the structure and completeness of markets and the depth of insurance markets heavily influence welfare costs.

For example, the premise of Lucas that all agents are identical and have access to fully developed capital markets has come under scrutiny. It is conceivable that while the costs of volatility may be low for some consumers (such as those with large savings or access to insurance markets), they may be excessive for others who do not have the means to insure themselves against these shocks.

This is mainly because households are insufficiently insulated from risk owing to the inaccessibility and/or unavailability of credit institutions and insurance markets. Therefore, having been exposed to shocks, vulnerable households are unable to smooth expenditures and income streams. Such households are likely to change their income-generating activities by diversifying towards low-risk technologies with relatively lower returns, as well as curtailing investment plans (Roumasset, 1976, 1979; Rosenzweig & Wolpin 1993; Dercon 2004; Fafchamps 2003).

Subervie (2008) demonstrates that producers in developing countries are particularly vulnerable to the fluctuations of world prices because they are widely exposed to price shocks and have little ability to cope with them. She shows that the effectiveness of risk-coping strategies is conditioned by the influence of macroeconomic factors such as infrastructure, inflation and financial deepening. Underdevelopment of infrastructure decreases a producer's capacity to cope with price instability, inflation increases a producer's vulnerability, while poor financial development discourages investment and self-insurance. Dehn et al. (2005) argue that a lack of diversification is both a reason for and the result of ineffectual risk coping mechanisms.

In this context, several studies have investigated the welfare costs of volatility for heterogeneous agents with limited access to capital markets. An extensive review can be found in Lucas (2003). Imrohoroglu (1989), however, assumes that individuals are subject to idiosyncratic shocks and face liquidity constraints. The resulting imperfect risk-sharing among agents leads to welfare cost increases at about three times that of Lucas' 2003 estimate.

Box 1.5: Four dimensions of producer vulnerability: a survey

Infrastructure. Several authors share the view that public investment in infrastructure has a positive impact on agricultural supply, especially through the influence by generating productivity increases (Binswanger & Deininger, 1997). In an analysis of agricultural policies in 18 countries between 1960 and 1983, Krueger et al. (1991) show that the macroeconomic environment and the supply of public goods may influence performance in the agricultural sector. They demonstrate that investing in rural infrastructure and coordinating with social services and viable systems of credit for small producers enabled agricultural production to rapidly grow and reduced poverty in Southeast Asia and China. Similarly, Heath & Binswanger (1996) point out that in Kenya, where infrastructure supports market access, growth in agricultural production more than compensated for growth in rural population; while in Ethiopia, a country deprived of infrastructure favourable to producers, the strong population density implied significant degradation of land.

Faini (1992) suggests that the level of infrastructure could improve the supply response to producer price changes - for example, by reducing the high costs for transporting locally produced commodities to the border for export through the development of road networks. It can be argued that infrastructure development may also improve the efficiency of public expenditure for education and health services. Agenor & Moreno-Dodson (2006) find that investment in infrastructure interacts with social public services, thus influencing growth via a complementary effect. In addition, Knight & Woldehanna (2003) and Weir & Knight (2004) suggest that education and health services can reduce producers' risk aversion. Moreover, infrastructure can help develop risk-sharing networks (Dercon, 2002; Fafchamps, 2003) and improve, in turn, a producer's capacity to deal with price volatility.

Inflation. Mundlak et al. (1997) have studied the direct effect of inflation on agricultural production in a cross-country analysis covering 37 countries between 1970 and 1990. Inflation can influence agricultural productivity directly as an incentive and indirectly via investment. However, it can also affect a producer's capacity to cope with price risk by reducing real producer prices and the real value of their savings. When inflation reduces the real value of a producer's revenues and assets and devalues precautionary savings, producers may be forced to reduce their supply. Furthermore, producers may be forced to liquidate their productive assets - land, cattle, bullocks and tools - in the face of price shocks, even though inflation makes such liquidation less profitable. Thus, inflation can exacerbate producers' responses to price volatility.

Financial development. There have been many attempts by the international community to deal with commodity price volatility, though these stabilization or compensatory mechanisms have been abandoned as financially unsustainable. International commodity agreements have either collapsed (sugar, tin) or have been replaced by agreements whose primary role is to improve information (cocoa, coffee) (Gilbert, 1995). While market instruments can reduce uncertainty arising from volatile prices, they are typically less effective for inter-year volatility. They are only used in a very few developing countries (which have relatively low levels of governmental intervention in terms of commodity production and trade of commodities) and, as of yet, have hardly provided a global solution. Microfinance can help producers cope with price volatility. Better access to credit markets helps improve productivity through increased savings and investment (Levine, 2004) and can attenuate supply response to price shocks by buffering income and revenue shocks. Although informal mechanisms of credit and insurance are most common (see Besley, 1995), the development of formal credit institutions can influence the risk-coping capacity of producers in an indirect manner. Guillaumont Jeanneney & Kpodar (2005) argue that the development of informal credit, which is often the only source of borrowing for the poor, is made easier by improving the formal financial system, which offers profitable investment opportunities to informal financial institutions that are not directly offered to small producers (Beck et al., 2004). Furthermore, the formal financial system gives producers financial opportunities for savings. Producers who are forced into self-financing and self-insurance have access to interest-linked deposits, and thus have a savings incentive (McKinnon, 1973). Therefore, by facilitating the build-up of savings, financial development may also contribute to reducing the supply response to price volatility.

Lack of diversification. Farmers in many developing countries are prevented from participating in high-return activities because downside risks will be too severe in the advent of a crisis. Wealthy households can borrow during such times as they have assets that can be collateralized. Even if credit is unavailable, they are able to smooth their income by selling their assets. With no access to income buffers, poor households tend to restrict their enterprise to low-risk and hence low-return strategies. Behaviour here does not reflect risk preferences but rather reveals the lack of risk-coping strategies, such as risk management, insurance and finance.

Source: Subervie (2008); Dehn et al. (2005).

Research has also highlighted the importance of understanding the interaction between aggregate and individual shocks, as well as permanent and transitory shocks. Storesletten et al. (2001) demonstrate that in an environment where small shocks can have long-lasting impact on agents' income streams, the welfare cost of volatility can be much higher than the original estimates. Moreover, if the effects of a negative shock are assumed to be permanent (as in Krebs, 2003), then the welfare costs can be as high as 7.5 percent of consumption. In such a framework, even if credit markets are perfect, individuals will not borrow to smooth the negative shocks they face as the effect of those shocks will persist permanently.

In a similar vein, van Wincoop (1994) shows that if consumption follows a random walk, then the welfare gain associated with the entire elimination of variability is likely to be large because consumption will not revert to a deterministic trend. Prasad & Crucini (2000) use this result to ascertain the cost of eliminating risk posed by terms-of-trade volatility. Taking commodity import price data as a panel comprising 66 developing countries and representative export prices for 33 commodities, the authors show that the welfare costs of terms-of-trade volatility is substantial, amounting to around two-thirds of consumption on average across the sampled countries, and several orders of magnitude higher than that of Lucas' formula.

Pallage & Robe (2000) computed the welfare cost of output volatility in a series of low-income countries, and found that the median cost ranged from 15 to 30 times the estimate for the United States. Strikingly, for many of those countries, the authors estimated the welfare gain to be so large as to exceed that of receiving an additional 1 percent of growth permanently. Pallage and Robe conclude that "while policy advice to developing countries has focused heavily on growth, our results suggest that policies that reduce output volatility may bring about substantially higher welfare gains in countries other than the United States. Stabilization policies, at least for those countries, should not be dismissed too hastily".

Ramey & Ramey (1995) also demonstrate a strong negative relationship between volatility and growth using a panel of 92 countries, most of which are developing. They further identify that the negative effect of volatility arises principally from the volatility in the innovations to GDP growth, reflecting the role of uncertainty in economic decisions.

The indirect utility framework to measure welfare costs under volatility has also been applied to the household level in vulnerable developing countries. Recognizing that many farmers both produce and consume the same foodstuffs, it has been understood that there will be a range where households tend to be either price risk-averse, risk-neutral, or risk-loving (e.g. Finkelshtain & Chalfant, 1991, 1997; Barrett, 1996) for a commodity bundle (e.g. Turnovsky et al., 1980). The body of this work is motivated by the perception that: (i) poor households are widely believed to value price stability; (ii) the poor are widely perceived to suffer disproportionately from food price volatility; and (iii) futures and options markets for hedging against food price risk are either unavailable or inaccessible to poor consumers and producers.

Based on these premises, Bellemare et al. (2010) obtain total welfare impacts of price vector volatilities by considering the variance in each price series alongside the covariances among them. The authors argue that disregarding the covariances between prices for commodities i and j leads to bias in the estimate of the total welfare impacts of volatility unless price vector fluctuations are independent, which presupposes that commodities are neither complements nor substitutes. The welfare cost of volatility under this setting becomes:

$$\lambda \cong 0.5 \sum_{i=1}^{K} \sum_{j=1}^{K} \sigma_{ji} \gamma_{ji} \tag{9}$$

Bellemare et al. (2010) employ a panel dataset covering seven major food commodities from rural Ethiopian households and find that typical households are willing to forego as much as one-third of their consumption (including storage) to stabilize the price.

In light of such evidence, the welfare cost of volatility in developing countries, where insurance markets are nonexistent or are thin at best and capital markets are underdeveloped, appear to be much higher than in their developed counterparts. Eichengreen et al. (2003)

highlight that the economies of developing countries are hampered by international capital markets' lending constraints owing to sovereign risk exposure and the prevention of external borrowing owing to their currencies being non-convertible.

This is particularly true for governments of commodity-dependent developing countries that rely heavily on revenues from tariffs levied on imports and exports. Volatility in international prices causes revenues to destabilize, and given problems in accessing international capital markets, lower public investment will follow and economic growth will be interrupted.

Summary

Historically, bouts of extreme volatility in agricultural commodity markets have not been common. Like natural disasters, they have a low probability of occurrence but bring with them extremely serious risks and potential high costs for society. Economic adjustment to sustained periods of either high or low prices can be accomplished. However, this is not true for when prices become volatile: adjustment is at best very costly but more likely unattainable.

The Nobel Prize-winning economist Milton Friedman argued that volatility means that market prices are a less efficient system for coordinating economic activity. In his Nobel Memorial Lecture, he states:

> *A fundamental function of a price system ... is to transmit compactly, efficiently, and at low cost the information that economic agents need in order to decide what to produce and how to produce it, or how to employ owned resources. ... If the price level is on the average stable or changing at a steady rate, it is relatively easy to extract the signal about relative prices from the observed absolute prices. The more volatile [are prices], the harder it becomes to extract the signal about relative prices from the absolute prices: the broadcast about relative prices is as it were being jammed by the noise coming from the inflation broadcast. ... At the extreme, the system of absolute prices becomes nearly useless, and economic agents resort either to an alternative currency, or to barter, with disastrous effects on productivity.* (Friedman, 1976)

Friedman makes the link between volatility and uncertainty, and how it can undermine economic decision-making, resource allocation and, ultimately, the efficiency of the price system. Consequently, measures of volatility must explicitly account for uncertainty.

At a deeper level, episodes of sustained volatility generate considerable uncertainty. They spawn increased risks in productive activities and undermine food security and economic growth in developing countries.

Interventionist polices that aim to bring stability have been discouraged given the lack of clear evidence, supported by theory, that price volatility has adverse macroeconomic consequences. However, this theory presupposes that markets are complete, insurance and credit markets are well-functioning and accessible to all, and furthermore, that shocks are mostly transient. These assumptions do not characterize the environment facing many developing countries. Extreme price shocks clearly expose the vulnerability of poor nations.

More worrisome is that large negative shocks to welfare can lead to irreversibility, setting in motion a downward spiral of rising vulnerability as fragile coping mechanisms are diminished. Crisis and extreme volatility generate risk and asymmetry of impact, which impedes growth, accentuates poverty, leads to malnutrition and increases political insecurity and the risk of internal conflict.

Seeing vulnerability as closely tied to the causes and consequences of volatility, measures to reduce vulnerability - both at the macroeconomic and at household levels - must be part of the overall solution.

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Chapter 2

Commodity prices: theoretical and empirical properties

Matthieu Stigler[1]

> *Though there has been progress, the understanding of commodity prices and the ability to forecast them remains seriously inadequate. Without such understanding, it is difficult to construct good policy rules.* (Deaton, 1999, p. 24)
>
> *It is sometimes argued that if economists really understand something, they should be able to predict what will happen next. But [commodity] prices are an interesting example (stock prices are another) of an economic variable which, if our theory is correct, we should be completely unable to predict.* (Hamilton, 2009, p. 184)

This chapter aims to provide a thorough description of time series properties of commodity prices. A comprehensive understanding of these properties plays a key role in shaping agricultural and trade policy, as well as guiding the decision-making process of economic agents.

I focus on four indicators of a price distribution- its mean, volatility, asymmetry and kurtosis. For each of these indicators, I briefly outline relevant theoretical models and extract their respective predictions. I then review a few key findings from empirical studies associated with each indicator, and test them on a sample of 24 commodities.

Background

Periods of crisis and extreme volatility highlight the difficulty of predicting agricultural commodity price movements and has reinforced the need to understand their behaviour. Clarifying the characteristics of commodity prices - especially trends - is crucial for developing countries that rely on commodity exports or that import significant amounts of food. As Deaton (1999) emphasizes, a better understanding of commodity prices is necessary to construct good policy: it will help governments and development agencies shape policies and decide on which products require focus, and at the level of the producer, understanding commodity prices helps individuals make key decisions about which crops to plant.

The need to understand the complexity of commodity price dynamics has become more urgent against the backdrop of current tendencies to remove traditional governmental stabilization schemes (i.e. price bands and market intervention) in favour of transactions on globalized markets. By contrast to earlier years, when agents focused on the spot price only,

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they must now grapple with a wide range of complex factors including derivatives markets, futures and options, phenomena of normal backwardation, maturity effects, and the link between futures and spot prices.

It is beyond the scope for this chapter to do justice to the vast body literature dedicated to the various aspects of price commodities; instead I endeavour to review some stylized facts about commodity price dynamics. I describe the key features of a price distribution, namely what are known as its "moments" such as the mean, volatility, asymmetry and the presence of large values.

For each feature of the commodity price series under investigation, I begin by briefly discussing the predictions of mainstream price formation theories. I then review the body of empirical literature that analyses the empirical relevance of the prediction to each feature, and, when possible, I test the prediction on a sample of 24 commodities. The data are based on the efforts of Grilli & Yang (1988) to build an informative data set, which has been used widely in previous studies on commodity price trends. I use the disaggregated set as prepared by Pfaffenzeller et al. (2007). The sample contains commodities that differ significantly in terms of production typology: crops (rice, maize, wheat), livestock products (wool, lamb, beef, hides), plantation and forestry products (tobacco, cotton, tea, jute, banana, sugar, cocoa, coffee, rubber, palm oil, timber) and metals (lead, copper, tin, aluminium, zinc and silver).

Economic theories for commodity prices

The term "commodity" can refer to a variety of goods that may differ greatly in production (or extraction), use (as inputs or final goods for the consumer), or storability (from a few days for the banana to centuries for metals). Thus it seems logical to conclude that explanations for the behaviour of markedly different commodities will require different theories. Here, I give an overview of three theories of commodity prices: the storage model, the scarcity rent model and the cobweb model.

The storage model

There is one theory about commodity price behaviour that tends to dominate: the storage model. The storage model has a long history, beginning with writings of Gustafson (1958) and later exhaustively presented by Williams & Wright (1991). As Chapter 15 of this book discusses this model in detail, it is sufficient here to provide a brief description with an emphasis on the time series price properties that the model predicts.

The storage model studies how speculators will engage in commodity transactions based on their expectations of future price changes. Typically, when the actual price is below the level speculators expect to prevail in the next period (namely, the long-term mean of the price adjusted for storage and interest rate costs), speculators will store the commodity in order to sell it at a higher price during the next period. By contrast, when the current price is *above* the next period's expected value, speculators will not store the commodity. In the case when there are no incentives to store (the so-called stock-out case), price dynamics simply follow the path of the underlying supply shocks.

Clearly, the storage model theory is best suited for commodities which are easily stored and whose production is unpredictable (such as those dependent on weather conditions). In regard to the commodity groups analysed for the current study, the storage model is best suited to describe staple commodities and non-perishable plantation crops.

Scarcity rent

Although the storage model has also been applied to metals, specific features of the metal industry set it apart from other agricultural commodities. Firstly, metal production (actually extraction) is less influenced by weather uncertainties than most agricultural commodities are. Secondly, the best way to store metal is actually not to extract the product at all. Thus, the key economic decision to be made regarding metals concerns the rate of extraction rather than at the level of storage.

One of the first theories to address metals pricing is the theory of scarcity rent. This theory, which dates back to Hotelling (1931), states that because resources are non-renewable, owners will charge a higher price and thus receive a "scarcity rent". From the theory emerged the so-called Hotelling rule: a decision to extract resources based on an intertemporal arbitrage will lead to price changes corresponding to interest rate changes.

However, the Hotelling prediction does not seem sufficient to explain today's observed price movements, partly because its underlying assumption of finite resource availability has been undermined by constant new discoveries and technological change which allow for better extraction and use of lower quality ores (Krautkraemer, 1998).

The "Cobweb" model

Finally, mention should be made of a compelling model for predicting the prices of livestock products known as the "cobweb model." This model, which was introduced by Ezekiel (1938), considers price fluctuations as endogenous, rather than exogenous (as in the storage model). The storage model asks how exogenous shocks in the supply will be transmitted into price movements. By contrast, the cobweb theory explains that price variations are the results of the behaviour of market participants.

Agent's price expectations play a crucial role in the livestock industry, where the lag between producing decision and effective production can be up to 3 years. While both the cobweb and storage theories model how agents form their expectations, they are based on two fundamentally different assumptions: while the storage model assumes that agents have rational expectations, adherents of the cobweb model assume that producers have naive expectations. Thus, according to the cobweb model, agents will base their production decision on the prevailing price, even if they know that the next period's price will likely diverge (this explains the term "naive expectations"). By doing so, agents' expectations can create variations in price: when prices are low (high), they will reduce (increase) their production, so that the next period will see opposite high (low) prices.

Even though the model of naive expectations has been deemed improbable and has received little attention in the mainstream literature, it has not been altogether disregarded in the study of agricultural commodity pricing (see, for example Mitra & Boussard, 2008). A reason for continued interest is its ability to generate oscillatory prices, which are considered applicable in describing cattle dynamics. For example Aadland (2004, p. 1977) writes,

> *Aggregate cattle stocks are a peculiar economic time series. To the best of my knowledge, no other series displays such regular and lengthy economic cycles. The regularity of the cattle cycle, [...] is unmistakable-spanning approximately 10 years from peak to peak.* (Aadland, 2004)

As the other theories mentioned above do not account for such cyclical behaviour, this makes the cobweb model an interesting candidate to help predict cattle prices.

Firstly, it should be noted that the theories elucidated thus far consider markets free from government intervention. However, it is clear that price stabilization (especially minimum price programmes, see Chapter 1) and trade policies (see Chapter 17) may have important impacts on commodity price behaviour. Moreover, there are theories that emphasize the importance of the macroeconomic environment, such as the "overshooting" model of (Frankel, 1986, 2006), in which monetary expansion induces commodity price inflation in the short-run (see Chapter 3).

Properties of commodity prices

To describe the properties of commodity prices, I will look at four indicators – the "moments" – of a price distribution: its mean, volatility (variance), skewness, and kurtosis. Because the focus of this chapter is on time series dynamics, a key point of interest is whether these moments vary over time. Thus, I give special emphasis to the time persistence of the first two moments, namely the hypothesis of mean reversion and volatility clustering.

In the section that follows, I define the properties of commodity prices by investigating mean reversion and persistence, volatility, skewness, and kurtosis.

Mean: non-stationary or reverting? A debate

Price persistence: an explanation

One of the central characteristics of a price series is its *persistence*, i.e. its degree of auto-correlation. Persistence has a fundamental impact on the behaviour of a series, as it indicates, loosely speaking, how past changes will influence the course of future changes. Typically, series with high persistence will have a long memory, which means that past shocks continue to play an important role in determining the commodity's future price trajectory, and that returning to the series "attractor" will take a long time.

In Figure 2.1, the series shown in blue is simulated with an auto-correlation coefficient of 0.3, 0.6, 0.95 and 1, respectively. The clear pattern that emerges here is that the closer the coefficient is to 1, the more variation the series displays and the more unstable it appears to be.

The second series (in grey) shows the same series but with a one-period shock of 20 units occurring at time 50. Interestingly, in the case of low auto-correlation coefficients, the shock dissipates rapidly, i.e. the grey shocked series returns to the black after a few periods only. Alternatively, for series with high persistence values, the same shock has a much more pronounced effect; many more periods are required for the variable to return to "normal" levels. In the case of an auto-correlation coefficient of 1, the shock has a permanent impact, and the series exhibit infinite memory.

In this case, the series is said to be non-stationary (equivalently: containing a unit root), which means that its mean or variance will change over time. Alternatively, a series with a coefficient smaller than 1 have fixed mean and variance.

The degree of persistence also impacts series predictability. Series with a coefficient lower than 1 exhibit stable forecast intervals, while series with a coefficient of 1 show forecast intervals that expand over time. This means that they are impossible to predict, and that the probability of an increase at any given time is as likely as a decrease. Thus, no price trends can be inferred from the data.

In summary, the question of series persistence plays a crucial role and has very practical implications for the market participant. If a series is found to be non-stationary, there is little that can be done to forecast it; a sharp decline is as likely as a sharp increase. Finally, the question of a series' persistence is also relevant for modelling strategy, as non-stationary variables require non-standard statistical techniques.

Figure 2.1: The implications of series persistence for a simple AR(1) process

Source: Own simulations.

Price persistence: theoretical considerations

Storage model theorists tend to agree that agricultural prices should be stationary. The storage model seeks to show how, in the presence of an i.i.d. (independent and identically distributed) supply and a deterministic demand function, commodity storage induces price auto-correlation. But whether this auto-correlation leads to stationarity or non-stationarity (random walk) is not directly predicted by the theory.

In an influential article, Deaton & Laroque (1992) investigate how the storage model can replicate the relatively high, but still stationary, auto-correlation found in annual prices of more than 10 commodities. That the prices were found to be stationary appeared justified to the authors:

> *The random walk hypothesis seems very implausible, at least for commodities where the weather plays a major role in price fluctuations; a random walk requires that all fluctuations in price be permanent.* (Deaton & Laroque, 1992, p. 3)

The many studies employing competitive storage models that followed Deaton and Laroque's seminal 1992 paper (for example Deaton & Laroque, 1995, 1996 and Chambers & Bailey, 1996) seemed to adopt the same belief in price stationarity. Indeed, they sought to replicate high auto-correlation without asking whether or not the auto-correlation is generated by stationary or non-stationary series. But even Deaton and Laroque themselves challenged the storage model, as it appeared rather unable to replicate this phenomenon in empirical commodity prices. This discrepancy was recently resolved by Cafiero et al. (forthcoming) (see also Chapter 15), who found that after a small modification of Deaton and Laroque's approach, the storage model was indeed able to replicate high-correlations. However, none of Cafiero et al. (forthcoming) results predict values close to non-stationarity (see Figures 15.2, 15.3, 15.4 and 15.5), which casts doubt on the ability of the storage model to generate non-stationary series.

By contrast the theory of financial market efficiency considers non-stationarity to be a given. This theory, popularized by Fama in 1960, argues that for a market to be efficient, prices should not be predictable and will thus follow a non-stationary random-walk[2] (more precisely, a martingale, of which the random walk is one model). The rationale is that price predictability can only be temporary because predictability reveals unexploited patterns in prices that attract investors. It is the activity of investors trading in predictable patterns that will ultimately result in the cancellation of predictable pattern. Even though the efficient market theory has been challenged in recent years by results of behavioural finance studies (see Shiller 2003 for a survey) and also Chapter 14), findings nevertheless indicate that in most financial markets prices exhibit at least near non-stationary behaviour.

While both theories are based on rational expectations, one predicts stationarity while the other predicts non-stationarity.

Price persistence: empirical results

Empirical results of price persistence analyses differ greatly and depend on the frequency and type of price (whether spot or future) analysed. For example, scholars analysing price transmission generally use cointegration tools, as virtually all studies report non-stationarity in agricultural prices. By contrast, studies testing the Prebish-Singer hypothesis find more nuanced cases of stationarity, as will be seen below.

Indeed, an important body of literature has dealt with price stationarity in the context of the Prebish-Singer (PS) hypothesis. The PS hypothesis states that as the price of commodities decreases relative to that of manufactured goods (and services), the terms of trade of commodity-exporting countries deteriorates. The first causes cited for this phenomenon were the low income elasticity of commodity demand and the high prices caused by manufacturers' market power. These explanations have recently been disregarded in favour of those relating the deterioration of the term of trade to the quasi-infinite supply of labour in developing countries (Deaton & Laroque, 2003).

While the initial empirical tests of the PS hypothesis focused on detecting a significant negative trend, later studies, beginning with Cuddington & Urzua (1989), pointed out the importance of precursory testing for the presence of stationarity. Indeed, it is important to disentangle deterministic trends generated by almost stationary processes from stochastic trends generated by random-walks.

2 Although this is formally not a necessary condition – see Lucas (1978).

This observation gave rise to a flood of new studies applying various stationarity and unit root tests to the standard data of Grilli and Yang, which have been revisited each time new econometric tests have become available.[3]

While an exhaustive review of all the results testing the PS hypothesis is impossible, one can at best mention a few key developments. Recent studies have progressively modelled the trend component more realistically by allowing for a structural break (Leon & Soto, 1997), two structural breaks (Zanias 2005 and Kellard & Wohar 2006), a smooth break (Persson & Terasvirta 2003, Balagtas & Holt 2009), or by modelling the break with smooth components (Gilbert, 2006).

However, a complication that arises when testing the null hypothesis of a linear unit root against the alternative of stationarity with breaks is that the alternative is actually composed of two hypotheses, namely that of stationarity and that of structural break. Thus, rejection of the linear unit root test does not imply necessarily rejection of the unit root, but can be owing to rejection of the hypothesis that there is no break. The papers cited above use tests that are not immune to this problem. More accurate tests are provided by Lee & Strazicich (2003, 2004), who allow trends to be present both under the null and the alternative.

The long excurse on the methodological issues of testing for downward trends predicted by the PS hypothesis leads one back to the initial question of commodity price stationarity. While researchers have tended to rely heavily on Grilli and Yang's aggregated data, it has since been acknowledged that aggregate data may hide important disparities that exist within commodities. Thus, testing for each commodity separately is also useful.

A number of influential studies have tested the PS hypothesis on separate commodities. Kellard & Wohar (2006) applied unit root tests to 24 commodities and found that 14 appear to be trend stationary once structural breaks are taken into account. Ghoshray (forthcoming) argues that the rejection of unit roots tests in favour of stationary alternatives with structural breaks might be owing to the presence of a break in the null hypothesis as mentioned above. He applied Lee & Strazicich (2003)'s test, along with a battery of others, to the deflated prices of 24 commodities (including 18 agricultural commodities). When using standard unit root tests, Ghosharay found that 17 of the 24 series were non-stationary. Applying linear unit root tests against stationary series with one structural break, only 7 series appeared to be non-stationary. Finally, the number of series found to be non-stationary increased to 11 once the more appropriate test of Lee and Strazicich was used. Kellard & Wohar (2006) reached similar results finding 10 non-stationary series.

It is difficult to summarize the conclusions of these various studies, as the results are highly sensitive to the test used, and inference appears to be less than robust. It is even quite probable that these results will be challenged in the future with the arrival of new testing procedures.

Price stationarity: policy implications

Having concluded the academic debate I now briefly discuss the policy implications of price stationarity. The first point to highlight is that there is significant uncertainty regarding the presence of trends in agricultural commodities. Furthermore, if trends do exist, they no not appear to last very long (with the possible exception of rice which is declining steadily). As Ghoshray (forthcoming) notes:

[3] To paraphrase Maddala & Kim (1998), the Grilli and Yang data set has become the "guinea pig" of agricultural economists, much like what Nelson and Plosser's data set is for mainstream economists.

> *Forecasting of commodity prices proves to be difficult. The evidence suggests that policy recommendations would be difficult to implement given the mixed and varying trend results.*
> Ghoshray (forthcoming, p. 9)

Because there is uncertainty as to whether or not prices trend at all, and whether or not price shocks are persistent, the best solution at the national and producer level may be to diversify commodity production, which would hopefully reduce the risks associated with the persistence of shocks and price unpredictability .

Nonlinearities

The storage and TAR models Up to this point in the discussion, almost all of the unit root tests discussed were based on linear representation such as:

$$\Delta y_t = \alpha y_{t-1} + \beta_1 \Delta y_{t-1} + \ldots + \beta_p \Delta y_{t-p} + \epsilon_t \tag{1}$$

Such formulations, however, are not satisfactory on theoretical grounds. In fact, various theories conclude that commodity prices exhibit nonlinear behaviour.

In the storage model, for instance, the constraint that inventories cannot be negative induces a nonlinear feature, i.e. that there are two distinct price dynamic regimes. The first regime corresponds to the usual regime of positive stocks, with speculator activity introducing auto-correlation of price between i.i.d. harvests. But when there is a stock-out, a different price regime emerges in which price dynamics simply replicate the harvest dynamics.

This phenomenon of regime switching between periods can be captured using the so-called threshold auto-regressive model (TAR), which aims to estimate two regimes that are split according to a "threshold variable". When estimating the storage model, the threshold variable chosen is simply the price:

$$\Delta y_t = \begin{cases} \alpha_L + \beta_{1L} \Delta y_{t-1} + \ldots + \beta_{1L} \Delta y_{t-p} + \epsilon_t & y_{t-1} \leq \gamma \\ \alpha_H + \beta_{2H} \Delta y_{t-1} + \ldots + \beta_{2H} \Delta y_{t-p} + \epsilon_t & y_{t-1} > \gamma \end{cases} \tag{2}$$

The estimated "threshold value" γ can be interpreted in this context as the value above which stock-outs will occur. Thus, the TAR model estimates both the "critical level" as well as the dynamics specific to each regime. For instance, according to storage theory, the coefficient α_H in the second regime should be close to 0, and thus reveal the low auto-correlation of stock-outs.

Ng (1996) applied the TAR model to the original series used by Deaton & Laroque (1992) and detected nonlinearity in 5 of the 13 series. Her estimated threshold values were in line with Deaton and Laroque's results, and indicated relatively short periods of stock-outs (ranging from 3-25 percent of the sample). Whether or not there is low auto-correlation in stock-outs is difficult to establish owing to the small number of observations in these regimes. Arguing that the large standard errors may be owing to the small number of observations, Ng simply compared the values of the coefficients. She concluded that there was important auto-correlation in the stock-out regime which contradicted the storage model prediction. Ng's methodology of relying on estimates without taking into account their standard errors is certainly questionable (see Cafiero & Wright, 2006), but there are to date no other approaches to assess the auto-correlation in regimes that have such a small number of observations.

It should be emphasized that the storage model, which primarily helps describe commodities linked to seasons, is essentially a theory that helps understand price variations between crop years. This implies that using monthly instead of annual data cannot help us determine the validity of this model, and conversely, that the theory cannot help us determine price variations within a given year. Interestingly, other theories, which use daily or monthly time series instead of annual data do predict nonlinear behaviour.

Nonlinearity and financial theories The issue of price nonlinearity has also been considered by finance theorists. For example, some have investigated the connection between herding behaviour and price bubbles. The first statistical investigations of this sort looked at the multivariate relationships between prices and their fundamentals (Diba & Grossman, 1987). But because the validity of such multivariate analysis rests on the accurate choice of fundamental variables, other approaches that use price series only (Haas et al., 2004) have emerged.

The underlying idea of these univariate analyses is that the presence of an economic bubble translates statistically into auto-regressive coefficient values higher than 1, i.e. it causes *explosive* behaviour. Clearly, because the bubble is a temporary phenomenon, these theories also predict regime-switching behaviour. In these cases, regimes are said to exhibit *explosive* behaviour. As illustrated in Box 14.3 in Chapter 14, two different tests of explosive roots run on a daily price series indicated the presence of a price bubble during the 2006-08 turmoil in global agricultural markets.

Another theory in finance , also discussed in Chapter 14, finds nonlinearity by taking into account trading behaviour on financial markets by distinguishing between noise and informed trades.

Nonlinearity and livestock products Theories of nonlinearity have also been applied to the case of livestock products. As mentioned above, a prominent feature of cattle prices is their cyclical behaviour. Holt & Craig (2006) applied nonlinear models to hog-corn price series by highlighting the asymmetry in the supply response to prices. They pointed out that on-farm quantities can be reduced almost instantaneously (by slaughtering), while rebuilding animal herds takes significant time. Holt and Craig thus applied the so-called smooth transition model and found evidence of significant nonlinearities.

Volatility

As highlighted in the previous section, agricultural commodity prices tend to be characterized by a high rate of persistence that is difficult to distinguish from a random-walk, leading to uncertainty in future price movements. Another important factor that adds to this uncertainty is the high price volatility that characterizes agricultural markets.

Volatility can be defined in many ways (see Chapter 1 for a complete overview). Traditionally, volatility refers to unexpected price movements. There is indeed a part of price movement that can be expected, such as seasonality or trends (though the discussion above casts doubts on this fact). The notion of volatility refers rather to the *unexpected* price movements. Typically, volatility measures involve two phases: a filtering phase followed by an estimating phase. Evidently, the second phase will depend on the first, and misspecification of what is termed the "mean specification" will induce misspecification of the nature of volatility.

Theoretically speaking, the presence of volatility can easily be explained by the inherent configuration of supply and demand in agriculture. Supply cannot adjust easily in the short run, and is subject to significant weather uncertainty, while demand is also relatively low in the short run. According to these configurations, a simple weather shock can result in a significantly higher price shock.

Volatility: ARCH and GARCH models

Volatility has been extensively analysed in the field of finance, and the tools developed in this research have in turn been applied to commodity prices. I review here the main developments in the financial literature, discuss their application for agricultural markets, and question whether the dynamics of agricultural prices differ from those of financial asset series.

The simplest measure of volatility is the average of the variations of the logarithmic transformed series, which has the advantage of being easily interpreted as the mean percentage change[4]:

$$\hat{\sigma^2} = \frac{1}{T}\sum(\log(y_t) - \log(y_{t-1})) \tag{3}$$

This equation nevertheless assumes a constant variance over time. It is often stated that the variance tends to "cluster" during certain periods: periods of low volatility tend to follow low volatility, and high volatility tends to follow high volatility. Engle (1982) introduced a model to take this phenomenon into account by writing the conditional variance as an auto-correlated process. From this arose the Auto-Regressive Conditional Heteroskedastic model (ARCH):

$$\begin{aligned} y_t &= f(y_{t-1}) + u_t \\ u_t &= \epsilon_t \sigma_t \\ \epsilon_t &\xrightarrow{iid} \mathcal{D}(0,1) \\ \sigma_t^2 &= \omega + \alpha u_{t-1}^2 \end{aligned} \tag{4}$$

where $\mathcal{D}(0,1)$ is an arbitrary i.i.d. distribution with mean 0 and variance 1. Typical choices for the distribution include the normal (as in Chapter 8) or the Student distributions (as in Chapter 6 and 16).

In (4) the conditional variance σ_t^2 is assumed to depend only on the values of the previous shocks. The ARCH model was generalized by Bollerslev (1986) who made the conditional variance depend also on its past values. This led to the GARCH model:

$$\sigma_t^2 = \omega + \alpha u_{t-1}^2 + \beta \sigma_{t-1}^2 \tag{5}$$

In the GARCH model, while the conditional variance σ_t^2 is time-varying, the process has an unconditional variance (given by $\omega/(1-\alpha-\beta)$) as long as the sum of the coefficients $\alpha+\beta$ does not equal 1 or above.

ARCH and GARCH models applied to agricultural commodities

When applied to agricultural markets, the presence of GARCH effects will depend on the type of series considered, as well as the frequency of the data. But interestingly, GARCH effects are not limited to high frequency future prices. Indeed, when modelling the quarterly prices of soybean, sorghum and wheat, Ramirez & Fadiga (2003) found evidence of volatility clustering.

Though volatility clustering has been widely observed empirically, there is a paucity of theoretical explanations for this phenomenon (Shiller, 1989). In the case of agricultural

[4] This stems from the fact that for small changes, the difference of the log of a series is approximately the percentage change – see Hamilton (1994, p. 438).

commodities, Beck (1993) showed that the storage model can induce ARCH(1) effects in prices. Her empirical investigation of the annual prices of diverse agricultural commodities confirmed this prediction as ARCH effects were present in storable commodity prices, but not in non-storable ones.

It is beyond the scope of this chapter to provide a detailed survey of the numerous studies that have used GARCH models to study the volatility of commodity prices. Therefore, I have chosen to highlight a few that address specific features of agricultural price volatility. I will discuss asymmetric responses of volatility, micro determinants of asymmetry, as well as the influence of macro-variables.

Asymmetric effects on volatility

Equation (1) shows that coefficient α estimates the effect of a "shock" on conditional variance. However, this effect does not need to be symmetric; it is possible that either positive or negative shocks impact the market in different ways. Such an asymmetric effect can be measured using the EGARCH models of Nelson (1991), or the GJR-GARCH model of Glosten et al. (1993). Using these models on financial data, it has frequently been observed that negative shocks cause greater volatility than positive shocks do. This asymmetry has been explained in finance by the fact that negative shocks represent "bad news" owing to the so-called leverage effect.

Interestingly, the situation tends to be reversed in the case of commodity prices: a price increase generates a higher volatility. This phenomenon can be explained by the storage model, where price increases show the tendency to deplete stocks and hence increase volatility. Beck (2001), for example, has found such asymmetry by studying annual prices of 13 commodities. In addition, Carpantier (2010)'s systematic investigation showed asymmetry to be robust across a sample of more than 10 daily commodity prices and across different sub-periods. A more thorough investigation is discussed in Chapter 16, where it is found that the asymmetric effect increases as the volatility level itself increases.

Micro effects on volatility: the Samuelson effect

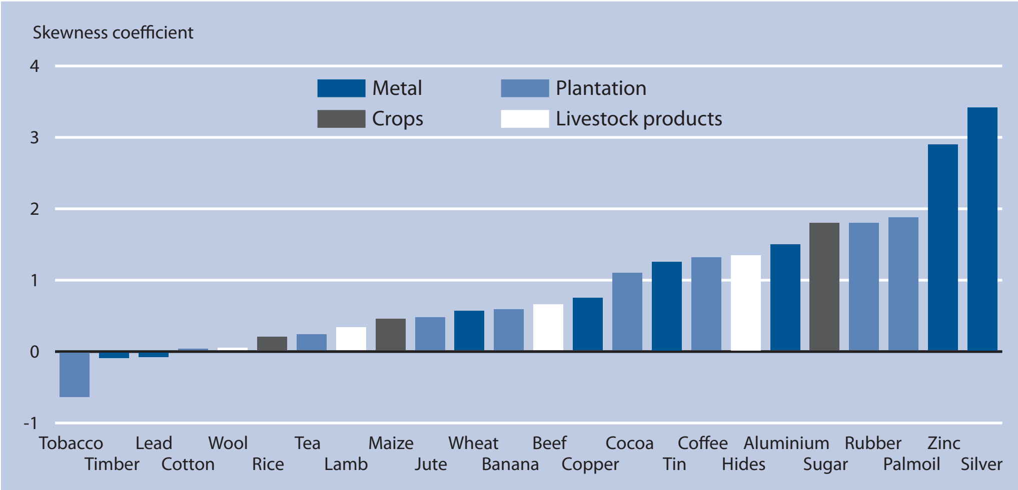
Using future prices instead of spot prices creates additional difficulties in modelling volatility. The first feature that emerges is seasonality, where, for example, volatility is higher at certain times of the year, typically at pre-harvest periods. More important is the so-called Samuelson effect, which states that volatility tends to increase as the maturity date of the futures contract approaches. This implies that futures contracts with the closest maturity (or even the spot price) exhibit a greater volatility than contracts at later maturities.

The Samuelson effect implies that by choosing to analyse a price series with the nearest maturity future, one introduces artificial volatility. The presence of the maturity effect for agricultural commodities has been confirmed by many studies, among others Milonas (1986), Kalev & Duong (2008) and Karali & Thurman (2010). Interestingly, Karali & Thurman find that the maturity effect significantly impacts the daily volatility of wheat prices, which is estimated to increase on average by 30 percent between the farthest and closest day to maturity. Using a synthetically constructed futures series with a constant maturity of 100 days rather than the nearby maturity can avoid the issue of maturity effects.

Volatility: macro determinants

Up to this point in the study, only conditional volatility is discussed, i.e. the volatility at time t given values at $t-1$. It is important to keep in mind that according to the GARCH model,

Figure 2.2: Skewness in commodity prices



Source: Own calculation based on Pfaffenzeller et al. (2007) data.

while the conditional variance is time dependant, the unconditional variance (the average volatility given all values) is assumed to be a constant, and is given by:

$$\frac{\omega}{1-\alpha-\beta} \tag{6}$$

It may also be fruitful to discuss whether the unconditional volatility varies with time. For example, it is generally claimed that while volatility in the 1990s was low, it increased significantly during the turmoil of 2006-2008. In an influential article, Schwert (1989) observed that indeed the stock-return volatility was evolving over time, and tried to determine whether this evolution was dependent on macro-economic variables.

A similar question has been asked by Roache (2010) in the context of agricultural commodities. Roache uses the spline-GARCH model of Engle & Rangel (2008) which decomposes volatility into two factors: short and long-run volatilities. Roache measured how the extracted long-run component of volatility was influenced by a set of 16 macroeconomic variables. Among these variables, inflation volatility and market volumes had a positive effect on volatility, while exchange rate and activity levels were found to have a negative impact.

Skewness

The skewness coefficient provides information about the asymmetry of a distribution. A value of 0 will indicate a symmetric distribution while a positive (negative) value will indicate a distribution skewed to the right (left).

Are there any theoretical arguments that predict commodity price symmetry? Once again one can look to the storage theory. Because inventories can only be positive (one can store now what will be consumed later, but one cannot consume now what will be produced later), the smoothing effect of storage will be effective to prevent decreases, but not increases.

How does this prediction translate into reality? Figure 2.2 shows the skewness coefficient computed on raw deflated prices. It indicates that commodities generally tend to exhibit a positive skewness, and thus conform to the storage model's prediction.

Because the storage model attributes price skewness to the action of storage, one would expect that a commodity's storability will impact its degree of asymmetry. But Figure 2.2 above does not confirm this hypothesis definitively. While one can find an overall positive skewness (except for the case of tobacco, which might depend on the very different dynamics of tobacco demand), the commodities that appear very similar in terms of storability do not seem to share the same skewness properties. For instance, easily storable commodities like metals can have either the highest (zinc, silver) or lowest (lead) skewness. Similarly, banana is a commodity that practically cannot be stored or in any case its storability is much less than wheat or maize, yet it has a higher skewness than either of these two commodities.

When discussing these conflicting findings, one should keep in mind that price asymmetry can also be owing to price stabilization policies. Indeed, the introduction of a floor price will introduce positive skewness in the prices. Conversely, a ceiling price can reduce positive skewness. It is, however, unclear how this helps explain the conflicting results above.

One might ask how skewness in a series will affect the estimation procedure, as usual models are based on the assumption of an underlying symmetric distribution. There are various ways to deal with this question. If the intent is to estimate the conditional mean equation, a simple method to use is the quasi-maximum likelihood (ML) approach. Specifying a wrong distribution for the maximum likelihood does not in fact greatly affect the estimation of the parameters (the estimator is still consistent in most cases), but it affects its standard errors. Thus, the quasi-ML proceeds to the estimation as if the errors were normal, but corrects for the variables' standard errors.

An alternative approach would be to specify the distribution errors directly by using an asymmetric rather than the standard normal distribution. This is more frequently done in the context of GARCH models, where the error distribution is nonetheless modelled specifically. Ramirez & Fadiga (2003) provided an example of such approach applied to commodity prices (wheat, soybean and sorghum), and found that taking skewness into account through a asymmetric distribution reduced the model's forecast errors.

From a practical perspective, the presence of positive skewness can help policy design. Indeed, positive price asymmetry implies that one can be quite confident in establishing a minimum price level[5] under which prices are unlikely to fall. On the other side, an upper bound is much more difficult to establish. That is, consumers or importing countries must be prepared for virtually any increase in price.

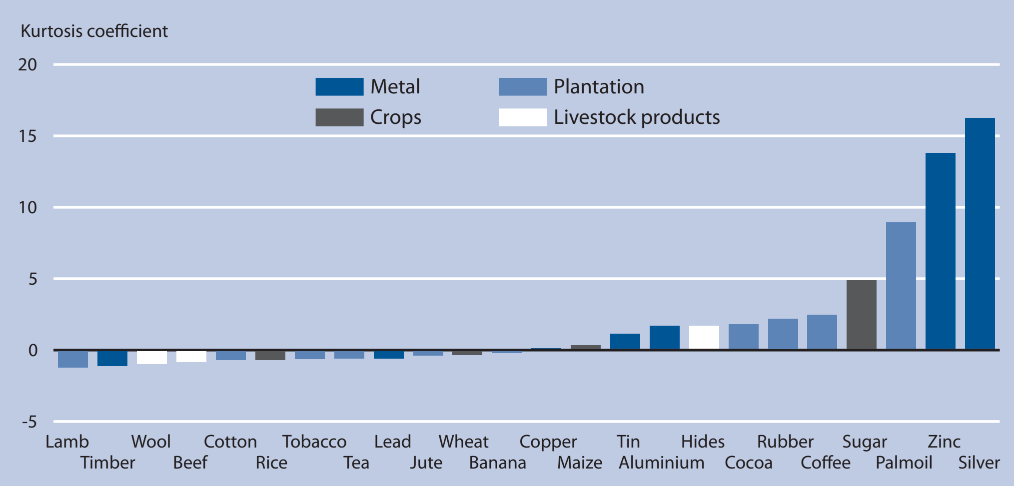
Kurtosis

The excess kurtosis of a distribution conveys the thickness of its tails, i.e. the preponderance of extreme values. A positive (negative) excess kurtosis will imply a distribution that is fat (thin) tailed, while a value close to zero will indicate a distribution with tails similar to those of the normal distribution.

Excess kurtosis is usually found in equity markets, which can exhibit high or extreme values. This is also the case for commodity markets. The storage commodity model again helps explain this phenomenon. Indeed, when inventory levels are extremely low or even zero, prices can spike very high. Thus, it is the alternation of frequent periods of low prices with rare periods of turbulence that leads to a significant price kurtosis.

5 Say a 2.5 percent quantile

Figure 2.3: Excess kurtosis of annual commodity prices



Source: Own calculations based on Pfaffenzeller et al. (2007) data.

Figure 2.3 shows the excess kurtosis of commodities sample. Positive excess kurtosis is found in half of the sample, while the second half exhibits negative excess kurtosis.

Conclusion

The aim of this chapter was to provide a description of the time series properties of commodity prices. For this purpose, focus was made on the key indicators of a price distribution – mean, volatility, skewness and kurtosis – both empirically and theoretically.

Regarding the first indicator – the mean – I focused mainly on how price series evolve around their means. The key issue here is whether prices tend to be stationary and revert to their mean, or instead follow an unpredictable random walk. I found that in theoretical studies, this issue remains ambiguous as there are arguments both in favour and against the random-walk hypothesis. This uncertainty is also present in empirical studies which produce contradictory findings. The results of empirical tests depend not only on the type of commodity investigated, but also on price frequency and even on the type of test used. Thus, I conclude that this uncertainty is a significant concern, as one cannot establish whether apparent trending behaviour is a permanent trend generated by a deterministic component, or rather an artifact owing to a stochastic trend. This implies that there is uncertainty about the persistence of shocks, and scholars cannot confidently predict whether shocks will be permanent or transitory.

Secondly, I discussed the importance of volatility and its persistence in commodity prices. I looked at studies using the GARCH model which is widely used in the context of financial markets. However, there are important features that distinguish agricultural from financial markets. A striking difference is that in agricultural markets, unexpected price increases tend to increase the variance, while in financial markets this leads to decreases. I further highlighted a few issues when constructing a price series to test for volatility, problems owing to the so-called Samuelson effect.

Thirdly, it was seen that commodity prices have an asymmetric distribution. While asymmetry is theoretically consistent with the storage model, the distribution of the asymmetry coefficient among commodities seems to contradict the model's predictions. In fact, while asymmetry is theoretically linked to the storability of a commodity, there was no clear link between asymmetry and storability in the sample. I also found contradictory results when examining price kurtosis. Indeed, the storage model predicts a positive kurtosis, which is found, however, in only half of the sample, the second half exhibiting negative kurtosis. These two results show that standard methods for modelling should be slightly modified as they are based on the assumption of normal errors. Secondly they indicate that causes of both asymmetry and kurtosis of prices, though commonly encountered, are still not fully understood.

The analysis presented and the literature surveyed in this chapter suggests that a fundamental understanding of commodity prices – especially between theory and empiricism – is lacking, which should be kept in mind in policy-design.

Firstly, one can see that many of the empirical results do not align themselves with the predictions of the storage model. Furthermore, it has been challenging to find common time series properties even among commodity groups that share many production features. The second issue concerns price persistence. It can indeed be seen that many prices appear to be non-stationary, or at least highly persistent, a fact that seems to be at odds with the mainstream storage model. This makes policy-making a difficult task, as predicting persistent prices lead to wide forecast error intervals that are of little use in practice. This suggests that Deaton's statement about the inadequacy of understanding of commodity prices, made almost a decade ago, remains valid.

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Chapter 3

Rising vulnerability in the global food system: beyond market fundamentals

Adam Prakash and Christopher L. Gilbert[1]

Chapter 1 drew the link between volatility and vulnerability, demonstrating that the degree of vulnerability is an inherent feature of extreme volatility: the severity of negative impacts on welfare and the extent to which it overwhelms the coping means of farmers, households and the wider economy, including economic growth. However, this chapter and the next argue that volatility is both a cause and consequence of vulnerability. The argument is framed in the context of both the resilience and response of food systems to shocks. When shocks are large - exceptional shocks - they can instigate a vicious cycle of rising fragility in response mechanisms that deepen and perpetuate volatility and its negative impacts on food security. Such fragility will be increasingly exposed to meet the greatest challenge of all - that of demography.

The latest UN estimates of population suggest that by 2050 the planet will be populated by 9.1 billion persons. This represents a near 33 percent increase over the next four decades. The implication according to FAO is that agricultural production will need to grow globally by around 70 percent over the same period (by almost 100 percent in developing countries) to feed this population because of the shift in demand towards higher value products of lower caloric content and an increased use of crop output as feed to meet rising demand for livestock products. Furthermore, these predictions of additional output are likely to be on the low side, as they do not consider a possible expansion in agricultural production to meet additional demand for biofuels.

Upon recognizing the sheer pressure on agriculture to meet the challenge of a rising global population, there remains little scope for productivity growth to deviate from this task without instigating further bouts of turmoil. However, achieving this task remains far from certain, simply because the trajectory of the global food system is no longer determined primarily by the physical quantity of food produced equilibrated with the quantity of food consumed. External shocks manifesting from a complexity of sources are having a profound influence in shaping the agricultural landscape. This complexity compounds uncertainty, and is driving vulnerability in food systems, and ultimately in food security.

Vulnerability, for instance, is being triggered by a series of factors that include: climate change and a dependence on new major exporting zones, where harvest outcomes are prone to weather vagaries; a greater reliance on international trade to meet temporary food needs at the expense of stock holding; linkages with other sectors, especially energy; and the broader

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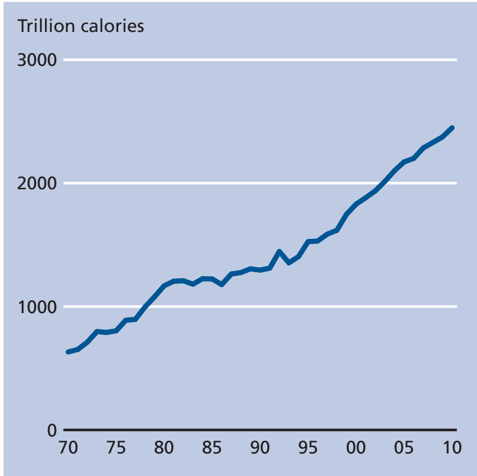
Figure 3.1: Global affordability of food: 1990-2010

Figure 3.2: Global food trade (trillion calories): 1970-2010



Source: FAO and World Bank.

transmission of events in the macroeconomy, including exchange rate volatility, inflation uncertainty, accelerating income growth in commodity dependent countries and changing monetary regimes through interest rate adjustments.

While many of these triggers are by no means new, a potentially worrying trend for global food security has surfaced in recent years. Financial institutions are progressively looking towards investing in commodity derivatives as a portfolio hedge, as returns in this sector are considered to be uncorrelated with returns in equities and other assets. The enormous sums of money being poured into commodities has led to suspicion that behaviour in commodity exchanges is amplifying volatility and causing persistence in the high prices of many foodstuffs that are strategically important for food security around the world.

After dwelling briefly on the context and the causes of the high prices and accompanying volatility afflicting markets in the past, we turn our attention to future prospects concerning the vulnerability of the global food system in coping with exceptional shocks from a complexity of sources. Especially interesting to us are those shocks that arise from outside of agriculture that transcend geographical boundaries, and thus present extreme covariate risks to societies.

The context of turmoil

The underlying reason that recent bouts of turbulence in food markets have caused such provocation has to do with the historical context in which prices and their accompanying volatility have arisen. Until recently, the notion of cheap food was considered the norm by consumers throughout the world. Indeed, up until 2006, the cost of the global food basket had fallen by almost a half over the previous thirty years or so when adjusted for inflation, with prices of many foodstuffs falling on average between the realm of 2 and 3 percent per annum. This tendency is clearly illustrated in Figure 3.1, which shows the "global affordability of food", that is, the average cost of food relative to world per caput income.

Declining real prices put farmers under considerable strain, except mainly in developed countries, where governments were able to provide support. Elsewhere, public and private sectors saw limited need or incentive to invest in agricultural production and infrastructure, as food imports appeared an efficient way of achieving food security. Such perceptions, though, changed radically when prices of most internationally traded foodstuffs began to soar in 2006.

The entire situation was by no means an accident. Technological advances greatly cheapened the cost of producing foodstuffs for quite a while. These advances and widespread subsidies in some Organisation for Economic Co-operation and Development (OECD) countries rendered more efficient and cheaper production elsewhere unprofitable and in doing so entrenched the role of a few countries in supplying the world with food.

Box 3.1: The rise of the global food system

At the beginning of the last century, the world's major economies adopted an interventionist stance towards international trade. For example, around 1900 the United States of America instituted into law much higher tariffs on agricultural commodities entering its borders, while other countries established commodity boards such as the Wheat Boards in Canada and Australia. In the post-war period, governments in most industrialized and industrializing countries sought to shield their productive sectors through broad-ranging and at times complicated protectionist measures. Export supplies for many commodities were managed through quota arrangements and price intervention under International Commodity Agreements.

The advent of "globalization" from the 1980s ushered in a new era of economic thinking. Protectionism and interventionism were now viewed as a hindrance to economic growth and so the policy paradigm shifted towards "trade liberalization". New thought was entrenched in neo-classical economic theory, in which free trade would ensure the most efficient distribution of goods, allowing the lowest cost producers to set price. This model - "the theory of comparative advantage" - if fully implemented, it is argued, can lead to a globally efficient food system characterized by low production costs and low food prices for consumers. Food is traded because it is perceived to promote economic growth and stabilize markets. The result is not just increased food trade but a model of food and agriculture that is premised on a single, global market in which capital, services and goods (but not labour) move unhindered around the globe.

A blueprint was then established that opened agriculture much more widely to the pressures of neo-classical economics and the imperative to trade internationally. The completion of the Uruguay Round in 1995 marked a complete overhaul of the global trading system with the founding of the World Trade Organization (WTO). But there were other institutional mechanisms that played a role. The financing function of the Bretton Woods institutions - the International Monetary Fund (IMF) and the World Bank - introduced conditionalities for developing countries in obtaining new loans or in negotiating lower interest rates on existing loans. Conditions were enforced under "Structural Adjustment Programmes" (SAPs) to allow economies in need of lending assistance become more market-oriented with focus on trade and domestic liberalization.

The recent lack of further progress in food and agricultural trade liberalization has shifted the focus onto regional and bilateral agreements as a means of liberalizing food trade. Notable examples include the Mercado Común del Sur or Southern Common Market (MERCOSUR), the Association of Southeast Asian Nations (ASEAN) Free Trade Area in Asia and the North American Free Trade Agreement (NAFTA). In the mid-2000s, as uncertainty about the progress of the Doha Round of WTO trade talks took hold, the number of regional trade agreements signed reached unprecedented levels. As of December 2008, 421 regional and bilateral trade agreements had been notified to the WTO and 230 agreements were in force.

Source: Based on Hawkes & Murphy (2010).

This supply-driven agricultural paradigm sent real prices spiralling downward on a trend lasting for decades. Starting in the mid-1980s, changes in the market and policy setting (see Box 3.1) have been instrumental in reducing stock levels and have led to far more planned dependence on imports to meet food needs, as seen in Figure 3.2.[2]

Taken together, these developments have imposed a heavy burden on major exporting countries to supply international markets when called upon. It is thus unsurprising that when production shortages occur in such countries, global supplies are stretched and the ensuing market tightness is manifest in both higher prices and higher volatility. This was precisely the case in the run-up to the episodes of extreme volatility that the world has recently witnessed. But the extent to which prices have risen and markets destabilized suggests the presence of other contributory factors beyond the resolution of demand and supply.

How crises in international agricultural commodity markets can unfold

Historically, bouts of extreme volatility in agricultural commodity markets have not been common. Looking back over several decades, two episodes stand out: the 1973-74 crisis and the 2006-08 episode. The latter event is not referred to as a crisis, rather as an "episode" as the level of (real) prices and volatility did not in any way reach the heights of the 1973-74 crisis. More compelling not to put both events on similar footing concerns the loss of life: using deviations from trend mortality rates, unofficial estimates put malnutrition related deaths resulting from the 1973-74 crisis at somewhere around five million persons (see FAO, 2009a).

Figures 3.3 and 3.4 show the sequence of events that preceded, triggered, amplified and perpetuated turmoil in both periods.

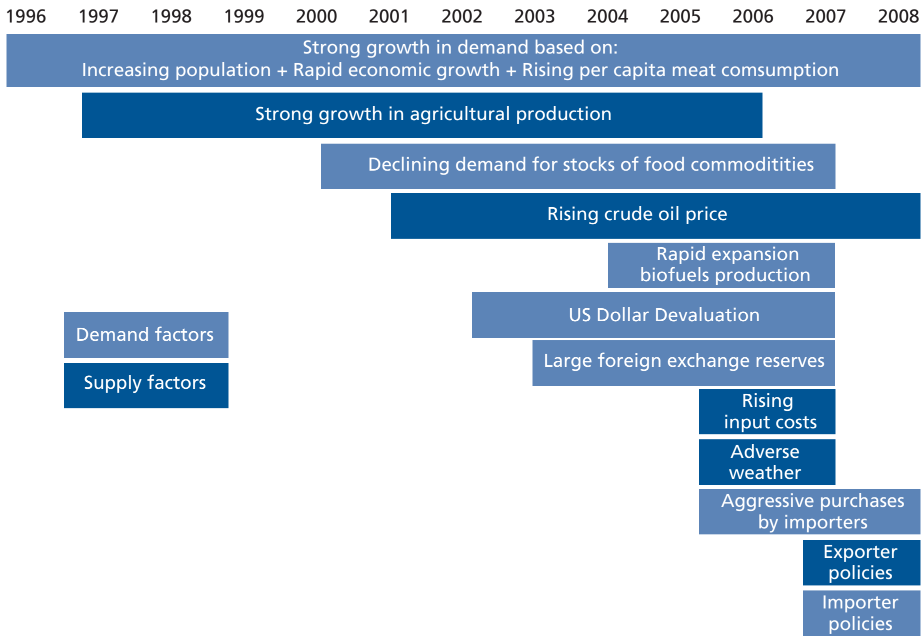
Contrary to common perceptions, macroeconomic factors were important in determining the 1973-74 crisis. This took place at the end of Viet Nam war that resulted in enormous macroeconomic imbalances in the world's leading economy of the United States of America. The crisis also began to unfold after the breakdown of the Bretton Woods fixed exchange rate system, which caused a substantial increase in international liquidity, leading to high inflation and low real interest rates.

The commonality of price rises and their subsequent falls is unlikely to have been coincidental, and is often overlooked by researchers who tend to focus on sectoral-specific events. "Commonality" may have arisen in either or both of two ways. The first is through common causation - a common set of driving factors (United States Dollar depreciation, monetary expansion, rapid demand growth etc.) may underlie price rises across a range of commodities, foodstuffs included. The second mechanism is linkages across markets - high energy prices may raise costs throughout the commodity producing industries, or the belief that commodities may be good investments in a stagflationary environment, setting the stage for investors to take positions across the entire range of commodity markets, again including food commodities.

The literature proffering reasons behind high price events, especially the 2006-08 episode, appears to have grown exponentially from the period when prices first began to show upward momentum. Many possible causes have since been identified, but ascribing relative importance to them still remains a puzzle for economists and policy-makers alike. Data

2 Notably, the high opportunity cost of storage in an era of falling prices; the development of less costly risk management instruments; greater access, flexibility and liquidity in international trade; and improvements in information and transportation technologies.

Figure 3.3: Timeline for the 2006-08 turmoil



Source: Adapted from Trostle (2008).

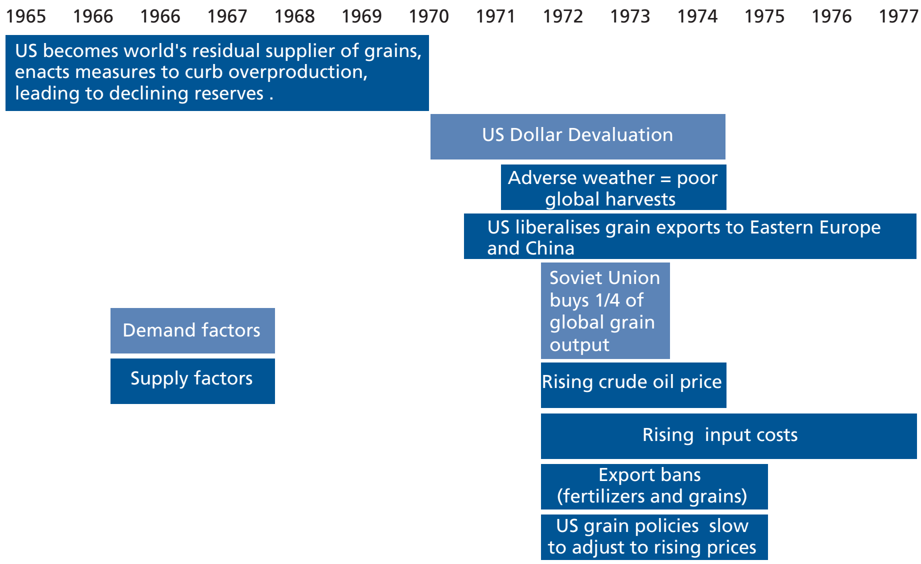
limitations, including a lack of observations and the presence of "discrete jumps" precludes a robust decomposition and attribution of causality. In addition, that expectations of economic agents and the interactions between causal factors are critical in price determination but unobserved further complicates the econometricians's task.

This volume, however, refrains from reflecting on this debate. Rather, our enquiry about the future prospects of the global food system for coping with sources of exceptional shocks necessitates an understanding of their transmission mechanisms. Nonetheless, as addressed in Part II of this volume, there are key policy lessons to be drawn from past events that serve to illustrate the importance of coordination and coherence in future government responses.

Exceptional shocks: sources and amplifiers

Commodity prices are volatile because their supply and demand are subject to variability. As mentioned in Chapter 1, it is useful to distinguish between predictable and unpredictable variation, the latter being characterized in terms of shocks - unexpected events. Shocks to both production and consumption transmit into price volatility. In the case of production, area or yield variations can arise owing to climatic disturbances, while consumption can shift because of changes in incomes, prices of substitutes, preferences and policies. However, owing to consumers' reluctance to revise habitual dietary patterns and, in poor countries, where few alternatives exist, consumption is generally regarded as stable. Consequently, it is

Figure 3.4: Timeline for the 1973-74 crisis



Source: Authors.

widely assumed that the most prominent source of shocks in agriculture that triggers turmoil stems from stochastic supply. Moreover, the impact of shocks on commodity prices is either moderated or amplified by the level of stockholding.

The degree to which shocks translate into price volatility is governed by the responsiveness of producers and consumers to changes in prices, i.e. the supply and demand elasticities. Leaving aside for the moment the behaviour of prices under stock regimes, empirical research has shown that both elasticities are generally low in the short-term, particularly within a crop year for supply elasticities, owing to entrenched consumption patterns.

Economic theory tells us that a rightward shift in a demand curve will, in almost all circumstances, lead to a price rise. However, the extent of the rise depends on the slope of the supply curve. If supply is very elastic, the price rise is modest. If supply is less responsive, the price rise is more substantial. If supply is very inelastic, even a small shift in demand can have a large price impact. There are two reasons why supply curves may be inelastic in crisis-type events.

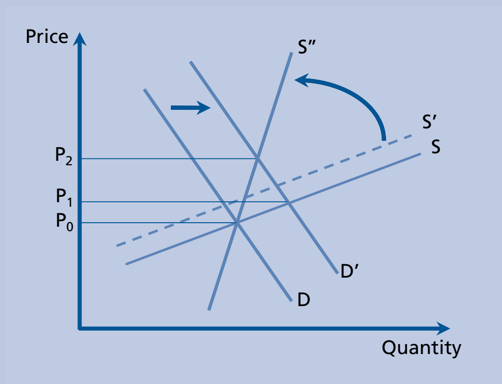
First, periods of escalating prices tend to succeed periods of low investment, which is often the outcome of a long-lasting decline in prices. Falling prices provide little incentive for investment that will likely curtail productivity growth and reduce the capacity of world agriculture to respond to price incentives, thus exacerbating price volatility.

The second factor affecting supply responsiveness is that markets are linked, which is illustrated in Box 3.2. Standard "additive" explanations of commodity price movements run in terms of price responses to a set of supply and demand shocks.

Box 3.2: Price responses to individual and common demand shocks

Consider a demand shock $D \rightarrow D'$ which is specific to an individual agricultural market. The appropriate supply curve in that market is S. Factors are drawn in from other markets and supply is elastic, with the result that the demand shock leads to the small price rise $p_1 - p_0$. If, instead, the demand shock is common across a range of agricultural markets, the position becomes more complicated.

Figure 3.5 Price response to shocks



First, there may be cost increases as outputs from one sector are used in others, e.g. energy inputs into agricultural production. This is reflected in the upward shift of the supply curve to S'.

Second, because the possibilities for reallocation of land and other inputs across crops are limited in the context of a common demand shock, additional factors are only available at considerable extra cost, making supply inelastic. The supply curve becomes less elastic, rotating to S. The result is that the same demand shock in terms of the market in question will lead to the much larger price rise $p_2 - p_0$.

If response coefficients are constant across the sample, price responses in crisis-type episodes may appear disproportionately large relative to normal times. This will tend to strain standard explanations of price changes in terms of market-specific factors. Second, and by implication, changes in commodity prices may be better explained by aggregative or macroeconomic factors that affect the entire range of commodity markets.

There is a tension evident in analysis of both the 1973-74 and the 2006-08 crisis between focus on market-specific factors and discussion of global factors (world monetary conditions, etc.). Market-specific factors can explain why the prices of some products rose and others did not, but macroeconomic factors may explain the extent of the price rises. Upon aggregating across the entire group of agricultural commodities, it would appear that macroeconomic and financial factors are most likely culpable.

Cataloguing sources of shocks and their amplifiers

Gilbert & Morgan (2010) note that it is logical for an increase in price volatility to arise through one or more of the following:

- a decline in the elasticity of demand and/or supply;
- an increase in the variance of demand and/or supply shocks

Figure 3.6: Actual (1980-2009) and projected (2010-15) GDP growth in China, India and the World (constant prices)

Source: IMF, World Economic Outlook Database, October 2010.

in which supply also includes inventories. Using this framework, the following illustrates the many different sources of shocks and their transmission mechanisms that are likely to shape food markets in the future.

Changing income growth Many researchers and commentators who emphasize the role of demand factors in the determination of food prices, pointed to rapid economic growth in Asia (see Figure 3.6) as the common driver of commodity prices, especially raw materials. If international demand growth accelerates, there may be a tendency for demand to be more volatile, which could translate into increased food price volatility, especially in the absence of stocks.

Price transmission Over time, greater market integration through globalization and trade liberalization tends to enhance transmission. On the other hand, governments often respond to higher prices through interventions at the border and consumer subsidies, which by shielding their sector from volatility, diminish price responsiveness on the part of consumers. This holds true for rice in much of Asia.

The degree to which prices on world markets are passed through to domestic prices is a major determinant of demand elasticity. Although price transmission may be generally high in developed countries, because the raw material (e.g. wheat flour) often accounts for a small share of the total value of the product (e.g. bread), high global price volatility will have a marginal effect on retail price variability. In low-income countries consumption is often relatively unprocessed with little value added to the raw material, so that primary product prices have a direct consequence on household budgets. Transmission, though, is often hindered by high transactions costs (including transport) that can result in local prices departing from those on world markets (see Chapters 7 and 8).

Box 3.3: Asymmetric price transmission and the strain on food security

More than one half of the 860 domestic price series monitored by FAO's Global Information and Early Warning System (GIEWS) were higher in July 2009 than they were prior to the 2006-08 episode. This is in contrast to international prices that had reverted back to their pre-2006 level by that time.

Applying regime switching cointegration techniques, Stigler & Tortora (2011) tested transmission asymmetry in wheat markets in India, Peru, South Africa and Ethiopia. The analysis begins with a standard Vector Error Correction Model (VECM):

$$\begin{pmatrix} \Delta p_t^A \\ \Delta p_t^B \end{pmatrix} = \begin{pmatrix} \delta^A \\ \delta^B \end{pmatrix} + \begin{pmatrix} \alpha^A \\ \alpha^B \end{pmatrix} ECT_{t-1} + \begin{pmatrix} \Gamma_{AA,1} & \Gamma_{AB,1} \\ \Gamma_{BA,1} & \Gamma_{BB,1} \end{pmatrix} \begin{pmatrix} \Delta p_{t-1}^A \\ \Delta p_{t-1}^B \end{pmatrix} + \cdots + \begin{pmatrix} \Gamma_{AA,p} & \Gamma_{AB,p} \\ \Gamma_{BA,p} & \Gamma_{BB,p} \end{pmatrix} \begin{pmatrix} \Delta p_{t-p}^A \\ \Delta p_{t-p}^B \end{pmatrix} + \begin{pmatrix} \varepsilon^A \\ \varepsilon^B \end{pmatrix} \quad (1)$$

where p_t^A represents the price in country A and p_t^B in country B. ECT denotes the error correction term, i.e. the deviations from the long-run equilibrium, i.e. $ECT_t = \varepsilon_t$ from $P_t^A = \beta P_t^B + \varepsilon_t$.

Under appropriate restrictions, we can test whether long-term adjustment dynamics are different in periods of positive/negative ECT, or in periods of positive/negative changes in the international price. This is done by differentiating the dynamics of the VECM depending on the state of the international price ($\Delta\ p^W$). However, it is reasonable to assume that adjustment only occurs when there are important variations in the international price. This implies the existence of a price band inside which there is no equilibrium adjustment, i.e. thresholds:

$$\Delta p_t = \begin{cases} \delta + \alpha^L p_{t-1}^w + \Gamma_1^L \Delta p_{t-1} + \cdots + \Gamma_p^L \Delta p_{t-p} + \varepsilon_t \text{if} \quad p_t^w = \theta_L \\ \delta + \alpha^M p_{t-1}^w + \Gamma_1^M \Delta p_{t-1} + \cdots + \Gamma_p^M \Delta p_{t-p} + \varepsilon_t \text{if} \theta_L < \quad p_t^w = \theta_H \\ \delta + \alpha^H p_{t-1}^w + \Gamma_1^H \Delta p_{t-1} + \cdots + \Gamma_p^H \Delta p_{t-p} + \varepsilon_t \text{if} \theta_H < \quad p_t^w \end{cases} \quad (2)$$

The results of estimating the model with three regimes are shown in the following table:

Table 3.1 Threshold vector error correction model: results

	Transition	Adjustment coefficient to ECT		Threshold estimate	
	Down	Middle	Up	θ_L	θ_H
India	ECT 0.06(0.07)	-0.06(0.20)	-0.04(0.44)	-0.069	0.040
	P^W -0.03(0.47)	0.07(0.10)	-0.01(0.77)	-0.013	0.006
Peru	ECT 0.07(0.74)	-9.3e-4(0.98)	0.10(4.6e-6)***	-0.013	0.106
	P^W *0.06(0.15)*	1.0e-2(0.79)	0.10(1.6e-4)***	-0.008	0.003
Ethiopia	ECT 0.85(1.9e-7)***	-0.03(0.89)	0.22(6.6e-6)***	-0.028	0.030
	P^W *0.67(1.1e-8)****	0.15(0.01)*	0.19(3.4e-3)**	-0.02	0.01

Of the four countries investigated, two of them (Ethiopia and Peru) showed a clear picture of transmission, while the results for the two others were rather obscure. In the case of Peru, one can see that the adjustment coefficients for positive deviations (in the third column) are significant, while those for negative deviations (first column) are not. This suggests that price transmission has been more effective in periods of world price increases than decreases, i.e. upward asymmetry. In the case of Ethiopia, however, it is the opposite: periods of negative deviations seem to lead to stronger adjustment than periods of international price increases.

Source: Stigler & Tortora (2011).

Another issue concerning price transmission is the symmetry of adjustment to shocks of equal magnitude - simply put, a unit negative shock to international prices should result in domestic prices responding in a similar manner to a positive unit shock. Symmetry, though, does not always hold. As Box 3.3 shows, the respite of lower global prices after the 2006-08 crisis was not felt by many consumers, which put an additional strain on their food insecurity.

As for producers, sustained underinvestment in agricultural sectors, as alluded to before, lowers supply elasticities, which ultimately can amplify price volatility. Their ability to respond to higher prices is constrained by a lack of access to capital, poor infrastructure, limited technology, limited information, few inputs and poor quality seeds. These obstacles translate into poorly-integrated markets where prices vary significantly between producers and consumers as well as from one area to another. This is evidenced in Box 3.4, which reflects on the experience of sub-Saharan African farmers during the 2006-08 episode.

Box 3.4: Producer price incentives in sub-Saharan Africa

United States Department of Agriculture (USDA) research recently examined the impact of higher food prices in sub-Saharan Africa. One aim of was to determine whether higher prices are being passed on to local farmers, who might then increase production and compete effectively with imports in regional markets.

In Ghana, for example, at the peak of global grain prices in mid-2008, the government provided subsidies for fertilizer and tractors. These subsidies were targeted principally towards poorer maize farmers, but even at the subsidized prices, many farmers were unable to afford fertilizer, let alone tractors. Fertilizer prices in Ghana increased by around 50 percent between April 2007 and August 2008. Marked price variations existed among different local markets to the extent that the difference in maize prices in two different towns - only 65 miles (105 km) apart - was almost threefold.

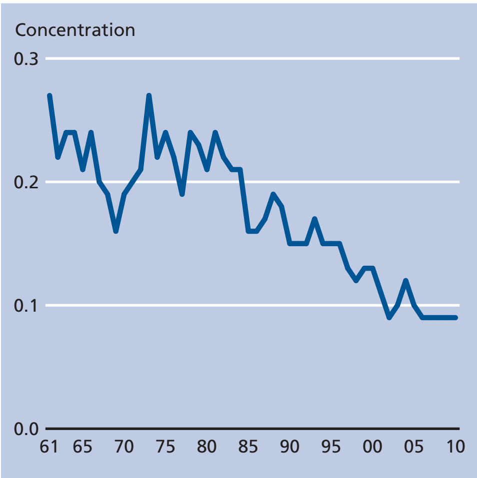
Similar issues were reported in Kenya, which is vulnerable to increases in world fertilizer and energy prices because all of its fuel and fertilizer are imported. Flat farmgate prices (despite rising consumer prices) and the increased costs of agricultural inputs (fertilizer prices tripled in six months) and transportation reduced food production incentives. This situation, coupled with domestic political unrest, meant that about half of the agricultural land in the northern Rift Valley (the key maize producing area) was not prepared for the 2008 planting season.

In the Republic of Mozambique, the recent high food prices were felt strongly at the consumer level, but the country's size and geography limited price transmission to farmers. With a fractured agricultural market and poor infrastructure hindering trade, opportunities for agricultural producers to capitalize on the relatively high and growing incomes in the urban areas are limited. The study found that at the market in Maputo, imported Argentinean maize was available for the same price as maize transported internally from the northern part of the country. This means that domestic production is more likely to be traded within rural communities or to rural areas of neighbouring countries, such as Malawi or Zambia, that face similar market infrastructure constraints.

In Uganda, despite growing demand, production response was low for various reasons. The primary factor underlying low productivity is land fragmentation - food production is dominated by smallholders with one to two hectares of land. These producers do not have access to credit markets and cannot afford fertilizer or high quality seed varieties. This situation has led to a decline in both land fertility and crop quality. Moreover, the food market (with the exception of sugar) is fully liberalized, meaning that there are no input or production subsidies and no tariffs on exports and imports. Government expenditures on agriculture accounted for about 1.5 percent of total expenditures in 2006 and 2007. With no farm organizations to enhance producers' bargaining power, cash-strapped farmers tend to sell their crops soon after harvest rather than store their crop and wait for higher prices.

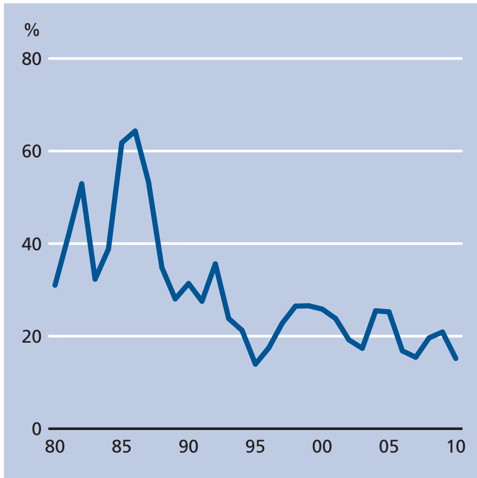
Source: FAO (2009b).

Figure 3.7: Geographical concentration in the global cereal market: 1961-2010



Note: The Herfindahl index, H is calculated as $H = \sum_i^1 NS_i^2$ where S_i is the market share of exporter i in the market and N is the number of exporters. Source: FAO.

Figure 3.8: Cereal stocks-to-use in major exporting countries: 1980-2010



Source: FAO.

Trade policies Border measures such as import tariffs and quota regimes may impede the transmission of resource-allocative signals contained in international prices, diminishing both demand and supply responsiveness. However, export restraints, including export taxes and outright bans, can equate to significant supply shocks which constitute a source and amplifier of price volatility. This is particularly true when restraints are introduced by major exporters and when they are unannounced and uncertain in duration. The lack of current rules disciplining the use of export restraints in the multilateral trade system lays a clear foundation for uncertainty ahead. The role of trade distortions in giving rise to food price volatility is discussed at length in Chapters 9, 10 and 17.

Export and industrial concentration The geographical concentration of global trade is likely to have a bearing on supply responsiveness. While a handful of countries continue to dominate supply in the international arena, at the margin there is an increasing number of countries which participate in exports (see Figure 3.7). Those that have emerged recently as regular international suppliers instil a large degree of uncertainty in the global market place through highly variable year-to-year production. This is particularly true for several rain-fed grain producing countries in the Black Sea region, which triggered turmoil in markets midway in 2010 when weather problems afflicted export availabilities. This feature can also shift the net-trade status of large producing and consuming countries from one year to the next bringing uncertainty to markets, as in the case of rice.

At the industry level, with the decline of state-trading, global export supply chains are progressively governed by fewer firms. While this may raise concerns over equity in the distribution of the gains from trade, it also raises concerns over the stability of trade flows - see Box 3.5.

Box 3.5: The governance of global trade

The process of market consolidation has been intensifying along commodity supply chains in recent decades at the global level. Today, Transnational Corporations (TNCs) can dictate significantly the patterns of international trade through intra-firm trade under their globally integrated production and marketing strategy. TNC activities are strategically organized and integrated either horizontally or vertically. This is reflected in their dominance in commodity value chains.

In agricultural commodity production and marketing, there are considerable asymmetries in market power and access to information, technology and marketing know-how between TNCs, on the one hand, and local entrepreneurs, farmers and traders in developing countries, on the other. Ironically, for small-scale producers and their governments, commodity markets have become fragmented, as TNCs have hastened the integration process of their operation globally. This parallel process of fragmentation and integration has often resulted in a hugely skewed distribution of gains from commodity trade. Under the prevailing market structures, the potential benefits of productivity improvements can be largely appropriated by the TNCs and global supermarket chains, instead of going to fragmented producers and farmers. The governance structures of primary commodity value chains have become increasingly buyer-driven with a shift in the distribution of value skewed in favour of consuming countries.

Source: Nissanke (2010).

Inventory supplies As discussed above, dependence on international trade in food-deficit countries has played an important role in reducing the demand for inventories for storable commodities.

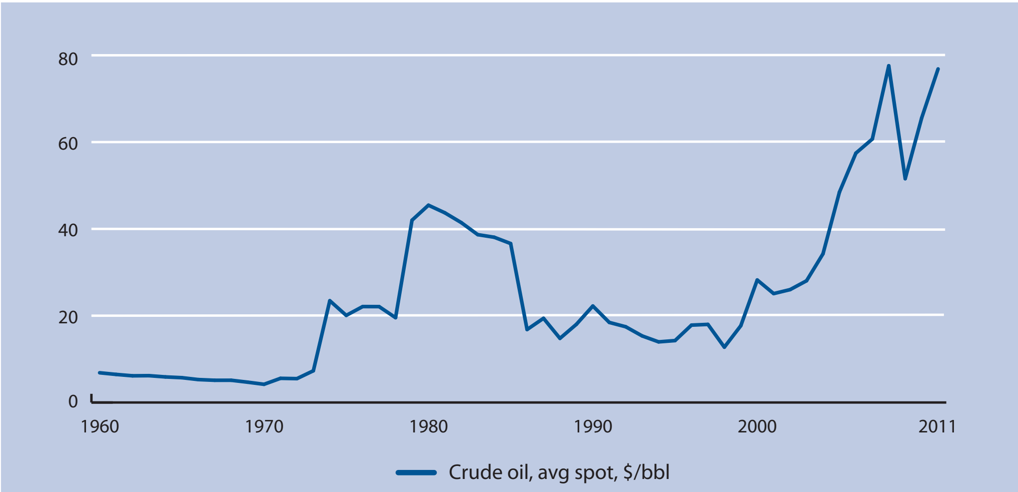
As long as production shocks are uncorrelated, this system will bring about benefits, principally in terms of efficiency savings. However, falling inventory levels reduce supply responsiveness to global demand shocks or to production shocks in major exporting countries.

Low stock levels can amplify price movements and cause persistence in volatility until inventories are replenished, especially in major exporting countries (see Figure 3.8). Depending on the size of the initial shock, this could take more than a crop year. This was brought home to governments in past episodes who found that reliance on trade for food security objectives is likely to fail in exactly those circumstances in which it is required (Gilbert & Morgan, 2010). The nature by which low inventory levels affect prices is presented in Chapter 12 and Part III of this book.

Energy Volatility in oil prices (see Figure 3.9) may increase the variance in food production. One link is through nitrogen-based fertilizers. A second is through transport costs. However, agriculture is not highly energy-intensive, and although there is a small positive correlation between the levels of real oil prices and real food prices, price changes are poorly correlated. Baffes (2007) estimates the pass-through of oil prices into agricultural commodity prices as 0.17. Mitchell (2008) estimates that over 2002-07, the combined effects of higher energy and transport costs have raised production costs in United States of America agriculture by 15-20 percent. Overall, therefore, we may see the agricultural supply curve as having shifted upwards to a medium extent as the result of higher oil prices in recent years.

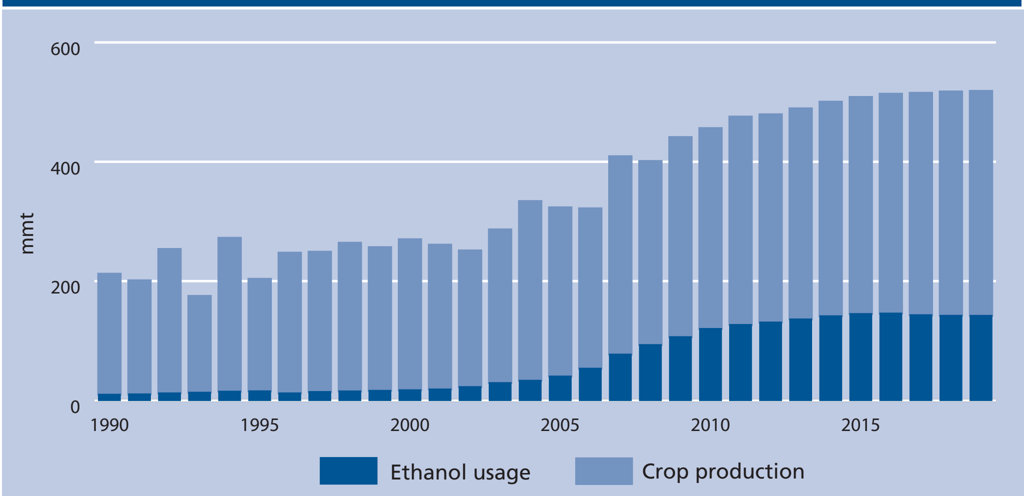
More important is that diversion of food crops for biofuels production (see Figures 3.10 and 3.11) has raised potential demand for food commodities, which will increase demand variance. However, through incentivizing change in land use, it has also had indirect effects on wheat and soybean prices and on livestock commodities through use of maize as animal feed.

Figure 3.9: Crude oil, average spot price: 1960-2010



Source: Global Economic Monitor, World Bank.

Figure 3.10: US maize production and ethanol usage, actual and projected

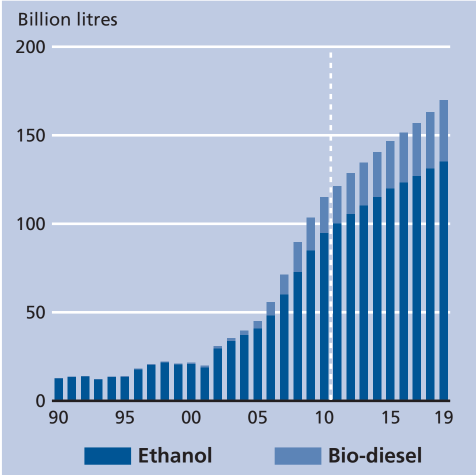


Source: OECD-FAO (2010).

Because biofuels still only account for a small proportion of total energy consumption, the long-run demand for grains and oilseeds for energy purposes becomes highly elastic at a price dependent on the oil and fertilizer prices. This generates a much closer link between oil prices and the prices of agricultural food commodities now than was the case in the past (see Chapter 8).

In order to examine these arguments more deeply, Schmidhuber (2006) provides a framework in which we can look at biofuels as a transmission effect from the oil market

Figure 3.11: Actual and projected global biofuel demand



Source: OECD-FAO (2010).

to food markets. He argues that the prices of crude oil and fertilizers define a break-even price for each of sugarcane, maize and palm oil at which production of ethanol or biodiesel yields zero profit. At lower prices, it will pay to divert production away from food and towards energy uses. In the long-run, demand for these commodities in a free trade world effectively becomes infinitely elastic at these break-even prices. (The infinite elasticity assumption follows from the small likely share of biofuels in total energy supplies). Mandates, subsidies and tariffs, such as the United States of America tariff on imported ethanol, complicate these relationships, but the principles remain clear. The consequence is that the grains and oilseed markets become integrated into the energy market and shocks to energy prices are transmitted in part to food commodities. Furthermore, as refining biofuel capacity is relatively inexpensive, price transmission from the oil market to food markets can be rapid.

This discussion suggests that, although the direct impact of a rise in the oil price on agricultural prices will likely exceed the direct pass-through into production costs; because the rise in costs is common across all agricultural commodities, there is little scope for reallocating land and other inputs across crops, and so supply elasticities will be low. Further, the rise in oil price results in a new highly-elastic demand component that puts an oil-price related floor under grains prices. Biofuels demand pulls agricultural production costs up until marginal production cost become equal to the exogenously given oil price parity level. It is tempting to attribute higher agricultural prices to high production costs, for example higher fertilizer prices, but, if the infinite elasticity assumption is valid, the causation is in fact in the opposite direction, from the grain price to production costs.

Exchange rates The impact of exchange rates on commodity prices has been analysed by Gilbert (1989) in a similar framework to that of Ridler & Yandle (1972) and is presented in Box 3.6. It is not easily discernible through which channels exchange rate uncertainty can manifest into price volatility. Almost all international prices are traded in terms of the United

States Dollar. Under flexible capital markets, changes in exchange rates reallocate purchasing power and price incentives across countries without changing the global food supply-demand equilibrium in the longer-run. This, however, does not preclude disequilibrium in the short-run.

A depreciation of the United States Dollar raises prices to producers and consumers in the country but lowers prices to consumers outside the country. This is because the United States Dollar price of the commodity on world markets will rise as the result of the depreciation, but by less than the extent of the depreciation, implying a fall in other currencies. Exchange rate variability therefore contributes to the variability of prices measured in United States Dollar terms, but would vanish if prices were measured in terms of an appropriately-weighted basket of currencies.

In practice, it is frequently found that commodity prices appear to exhibit excess sensitivity to exchange rate movements. One reason for this may be that both exchange rate changes and commodity price movements have a business cycle component that may not be fully reflected by available demand-side variables. A second reason may be because causation runs in part from commodity prices to exchange rates. But what is apparent are the inter-linkages between commodity prices, exchange rates and the monetary system as described in Box 3.7 by the Nobel Laureate, Robert Mundell during a FAO consultation (FAO, 2002).

Box 3.6: Exchange rate movements and international prices

The initial model assumes that there are N countries in a perfectly competitive global market, where each participating trading nation can be both a producer and consumer of the commodity in question. Long-term equilibrium in the market can be represented by:

$$\sum_{i=1}^{N} D_i(PX_i) = \sum_{i=1}^{N} Q_i(PX_i) \tag{3}$$

where D_i and Q_i are quantity demanded and supplied of the commodity respectively in country i, X_i is the exchange rate for country i expressed in terms of local currency per unit of the United States Dollar (the numeraire currency) and P is the world or market price expressed in United States Dollars. This market relationship can be used to identify the conditions required for the small-country assumption to hold, that is, for a change in the exchange rate of a particular country (X_i) to have no impact on world market price (P). The above equation can be totally differentiated and re-arranged to give:

$$\sum_{i=1}^{N} \theta_{D_i}\Phi_i\left(\frac{dX_i}{X_i}+\frac{dP}{P}\right) = -\sum_{i=1}^{N} \theta_{Q_i}\Upsilon_i\left(\frac{dX_i}{X_i}+\frac{dP}{P}\right) \tag{4}$$

where θ_{D_i} is the uncompensated own price elasticity of demand and θ_{Q_i} is the price elasticity of supply and in country i and Υ_i and Φ_i are the share of country i in total world supply and demand respectively. Solving for the percentage change in world price ($\hat{P}$) gives:

$$\hat{P} = -\sum_{i=2}^{N} V_i\widehat{X_i} \tag{5}$$

where $V_i = \left(\theta_{D_i}\Phi_i + \theta_{Q_i}\Upsilon_i\right)/\left(\sum_{i=1}^{N}\theta_{D_i}\Phi_i + \sum_{i=1}^{N}\theta_{Q_i}\Upsilon_i\right)$. Taking natural logarithms, it can be shown that a fractional uniform United States Dollar depreciation of Θ percent yields $d\ln P = -(1-V_1)\Theta$. Consequently, United States Dollar prices rise in proportion to the depreciation by a factor of one minus the United States of America' share in the world market.

Box 3.7: Mundell on commodity prices, exchange rates and the international monetary system

Prices are relationships between two quantities, a quantity of the object for sale and a quantity of a *quid pro quo* - usually money - offered for it. It may therefore be expected that changes in prices could reflect not only market-specific trends but also monetary development. In a world of inflation, for example, commodity prices would be rising, and in a world of deflation they would be falling. Both would be clear manifestations of monetary rather than real disturbances. There would not be a problem of "commodity price [instability]", there would be a problem of monetary stability. To analyse significant trends in commodity prices, therefore, it is important first to isolate the monetary disturbances (if they are present) from the real disturbances.

Superimposed on general movements of worldwide inflation or deflation are influences of exchange rates. In our world of multiple currencies and flexible exchange rates, commodity prices might rise in one currency but fall in another. The statement of commodity prices in United States Dollars could reveal either a problem concerning commodity prices or a problem of the United States Dollar. This brings up the question: in what currency or currencies should commodity prices be quoted?

In the post-war world, the United States Dollar was by far the most important currency in the world and had been since World War I. It was natural to use it as the basic unit of account and the convertible United States Dollar -the 1944 "gold dollar"- was the anchor for exchange rates. Parities for currencies were expressed in weights of gold (the United States Dollar was 1/35 of an ounce or .888671 grams of gold), but currency units and exchange rates were more normally expressed in terms of the more familiar gold dollar. As long as the United States Dollar was exchangeable into gold at USD 35 an ounce, the currency had the legal role and legitimate status as the international unit of account. It was natural also to use United States Dollar quotations as the basis for the index of commodity prices. That changed when the international monetary system broke down in the early 1970s. The United States Dollar was no longer convertible into gold, and foreign currencies were no longer convertible into the United States Dollar. The currency lost its judicial status as both monetary anchor and unit of account.

Exchange rates became flexible. The IMF Board of Governors then officially scrapped the IMF constitution based on fixed exchange rates and officially accepted the new regime of market-based managed flexible exchange rates. The idea was to let markets determine exchange rates. At the same time it was decided to rid gold of its mystique, and to auction off at least part of IMF gold stocks as well as United States of America Treasury holdings, and to introduce in its place as a numeraire the index of the value of a basket of a few major currencies that the Special Drawing Rights (SDR) had become. Unfortunately, at that time there was little understanding of how the new regime would work or what would fulfil the functions of gold and the United States Dollar. Unlike the previous system, which had been built upon the experience of hundreds of years of monetary history, there was no precedent for the new regime of paper currencies connected by fluctuating exchange rates. In addition, there had been little theoretical analysis of the problems likely to be encountered.

One of the problems had to do with the use of a unit of account. With all currencies on the same footing, international payments would be in chaos. At the most rudimentary level, how would exchange rates be quoted? With n currencies in the world there are $1/2n(n-1)$ exchange rates. If $n=200$ there are 19900 exchange rates! Flexible exchange rates in the absence of a numeraire in which to express currency prices would create enormous confusion. Fortunately, the market found the solution.

Under flexible exchange rates the United States Dollar was more rather than less important than before. Exchange rates were quoted mainly in United States Dollars, the currency most frequently used in exchange markets and the main reserve asset (apart from gold) of central banks. There was no longer any legal basis for using the United States Dollar as the numeraire for expressing exchange rates but it was the expedient solution. Dollar exchange rates gave some coherence to international monetary transactions. But this was far from a solution. The usefulness of a currency as numeraire depends partly on its stability. But was the United States Dollar stable?

There would have been no problem if the United States Dollar had been stable *vis-à-vis* other currencies. But in fact that has not been the case. However, looking for a single cause is simplistic. For example, there are two kinds of mistakes that one can make in relating exchange rates to basic real commodity prices. One is to say that exchange rates do not matter, while the other is to consider exchange rates as responsible for a whole series of different problems. In fact, in the short-run they matter, while in the long-run they do not matter very much. Therefore, it would be a good idea to reform the international monetary system in order to avoid any possible link between exchange rates and commodity prices. The link between the commodity price cycle and the United States Dollar cycle is apparent, but the underlying causes are not clear. Obviously, arbitrary exchange rate changes can lead to commodity price changes, United States Dollar prices may not reflect truly trends in real commodity prices. Prices in SDR terms would be better, as would an index of gold prices in some cases. Using some other types of measures, the swings in commodity prices are much attenuated.

Source: FAO (2002).

Monetary factors The channels through which monetary growth is transmitted into agricultural prices are diverse and also variable over time. Further, it is important to distinguish between unilateral monetary expansion in a particular economy, which will primarily affect agricultural prices through exchange rate depreciation and expansion at the global level, which may leave exchange rates unaffected, at least in the long-run (see Figure 3.12). Interest rate effects on agricultural prices may be more pronounced in periods of excess supply rather than when supplies come under pressure.

Monetary explanations of changes in price levels and relative prices attracted wide support in the nineteen seventies and eighties. Bordo (1980) and Chambers & Just (1982), who considered the impact of monetary growth on agricultural prices, found that monetary expansion could raise agricultural prices relative to a more general price deflator. By contrast, Awokuse (2005), who used more recent data, concluded that monetary factors had relatively little impact on agricultural prices. Instead, he saw changes in these prices as determined primarily by changes in input prices and by exchange rate movements.

A resolution of this conflict may be found by considering the monetary transmission mechanism. Noting the unreliability of the commonly used monetary aggregates, Taylor (1995) stresses the role of the prices of financial assets in the transmission process. In particular, exchange rate changes play a central role in this process. An implication is that we should expect different results from a unilateral monetary expansion in a single country, say the United States of America, than from a general expansion across the entire world. In the former case, the impact of monetary expansion will be felt primarily through United States Dollar depreciation, while in the latter case, exchange rates may not change markedly and transmission will be through other channels. Considering the effects of United States of America monetary policy on the country's agricultural prices, Awokuse (2005) indeed found that exchange rates were the primary determinant of price changes.

A perennial difficulty with monetary explanations of macroeconomic phenomena is that transmission channels can vary over time and that, depending on the channel, transmission can be more or less rapid. Friedman (1960, 1961) famously noted the importance of "long and variable lags" in the exercise of monetary policy. This variability hinders structural modelling of monetary phenomena and can result in scepticism in relation to monetary explanations even when non-structural tests suggest that monetary growth is important.

A second transmission channel - real interest rates - emphasized by Taylor (1995), illustrates these problems. Resource scarcity arguments suggest that we should expect a relationship between real commodity prices and real interest rates in the long-run[3]. But in

[3] This issue is discussed in Chapter 2 of this volume.

the short-term, the main route by which changes in interest rates will affect agricultural prices is through changing the expected return from holding inventory. If we regard titles to commodity inventories as financial assets, we should expect interest sensitivity to be measured by the likely duration of the holding, which will be longer in periods of excess supply than periods of excess demand. This suggests that interest rate changes should perhaps be more important in explaining low than high prices.[4]

Monetary expansion also triggers expectations for an increase in the inflation rate and causes investors to move away from liquid assets towards other investments including commodities, which means "overshooting" their long-run equilibrium level and increasing proportionally more than the money supply and the general price level in the short-run. This upward trend in commodity prices will be reined in as commodities will be considered "overvalued" by the market as compared with other goods (Frankel, 1986, 2006).

Previous episodes of sharply-rising prices in agricultural markets took place contemporaneously not only with surges in other commodity prices but also in equity and real estate prices. This suggests that, in an environment where central banks were controlling goods prices, monetary growth may have spilt over into asset prices. Svensson (1985) sets out a cash-in-advance model that implies this. Agricultural futures markets provide a possible route through which this transmission may have taken place.

Futures market activity As detailed in Part III of this volume, there are active futures markets for many of the most important agricultural commodities for food security traded on global markets. These markets facilitate the transfer of risk from so-called "commercial" traders, generally referred to as hedgers, who are exposed to movements in the commodity price through their regular commercial activities, to "non-commercial" traders, often referred to as speculators. A second important function of futures markets is price discovery – markets allow agents who believe they have information to trade on the basis of that information.

Finance theory distinguishes between informed and uninformed speculation (see O'Hara, 1995). This information may arise from knowledge of the markets or from research. Informed speculation is expected to have an impact on the market price. If speculative trades are both informed and sufficiently large, or if sufficiently many traders share the same information, the price will move accordingly and the information becomes embedded in the market price, which is more informative as a consequence.

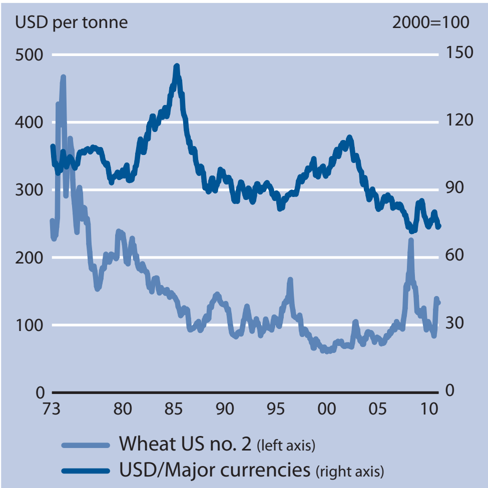
Efficient-markets theorists argue that commodity price rises have been driven completely by market supply and demand fundamentals and that futures markets form the mechanism by which information about fundamentals becomes incorporated in market prices. A related argument is that monetary expansion or futures market activity can only affect agricultural prices in so far as they affect inventory levels.

Standard theory implies that the price of any particular futures price should follow a random walk process with the price "innovations" representing new information impounded into the market (see Samuelson, 1973). According to this theory, if uninformed traders move a market price away from its fundamental value, informed traders, who know the fundamental

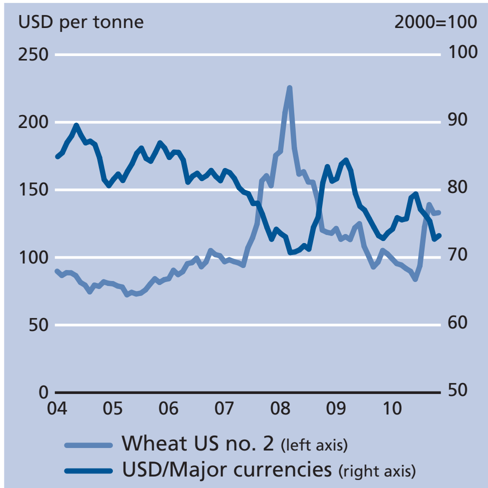
[4] This transmission of the monetary impact on storable commodity prices is determined by inventory behaviour. Inventory accumulation and depletion is shaped by an arbitrage condition that, in equilibrium, precludes a difference between the interest rate and the "convenience yield" (the sum of expected rate of increase in commodity prices minus storage costs). For example, an increase in the supply of money causes interest rates to fall, thus increasing the incentive to hold inventories. As the demand for storable commodities is strengthened and quantities are withdrawn from the market and brought into storage, commodity prices increase (FAO, 2010).

Figure 3.12: Monetary variables and food prices

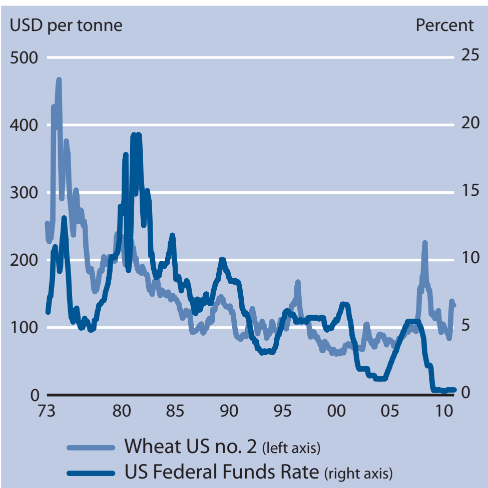
(a) US Dollar exchange rate and wheat prices (annual): 1973-2010



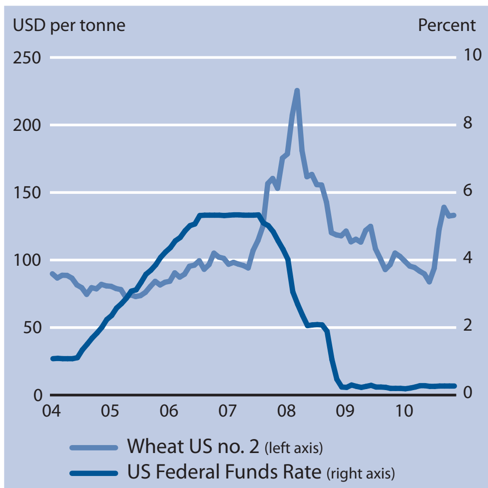
(b) US Dollar exchange rate and wheat prices (monthly): 2004-2010



(c) Interest rate and wheat prices (annual): 1973-2010



(d) Interest rates and wheat prices (monthly): 2004-2010



Source: FAO, United States Federal Reserve.

value, will take advantage of the profitable trading opportunity with the result that the price will return to its fundamental value. The informed speculators stabilize prices as set out by Friedman (1953). This argument supposes that all trades are informed.

Because the information content of futures trades only becomes clear over time, futures purchases will raise prices in the same way, although for later delivery and generally to a lesser extent, than cash prices. For the same reason, uninformed futures market purchases may result in inflated prices.

Recently, a significant number of institutional investors (managed money funds) have started to invest in commodity futures through index-based swap transactions as a portfolio diversification strategy and to assume exposure to the commodity "asset class", commonly referred to as the "financialization" of commodities. The problem with such derivatives is that they can also create risk and uncertainty on a massive scale.[5]

Positions are often large in relation to total activity - in the CME wheat contract, swaps dealers comprise about 40 percent of long open interest or almost one billion bushels (27 million tonnes) - equivalent to 2.5 times the size of the United States of America soft red winter wheat crop. These positions are predominantly long, i.e. they involve purchase of futures contracts, which are then held to hedge over-the-counter (OTC) transactions. These transactions are not transparent and are not regulated or traded on exchanges, as the parties make the majority of them as private contracts. Because these derivatives spread risk of prices or events around to parties that the markets do not fully know about, they create a great amount of uncertainty.

Summary

Acknowledging the enormous strain on food systems to meet the needs of a rising global population, the scope for productivity growth to deviate from this challenge without triggering episodes of high volatility and crisis is limited. But, rising to this challenge remains far from certain. For the trajectory of the global food system is no longer simply guided by the resolution of demand and supply fundamentals. Exceptional shocks from a host of external sources are having a profound effect on the agricultural landscape. Many of these shocks transcend international borders, spilling over from other sectors, and have the potential to amplify and perpetuate volatility. External shocks are compounding uncertainty, and are driving vulnerability in food systems and ultimately food security.

Future crises and episodes of severe market turbulence could be largely driven by macroeconomic factors, such as high and volatile income growth, expansive monetary regimes, exchange rate uncertainty, oil price volatility transmitted largely via biofuel demand and non-commercial investment in futures markets. Even though past crises and episodes of extreme volatility were born out of many of these influences, it is, however, likely that they will also play a greater determining role in the years to come and could be behind a permanent increase in volatility as evidenced by the secular rise in implied volatility (see Figure 1.3 in Chapter 1).

The degree of price transmission will ultimately guide how countries and their societies are impacted, but low transmission is in itself a source of vulnerability. In failing to respond to global supply scarcity, producers around the world will potentially heighten and prolong crises. Price signals that induce farmers to grow more may in many cases not be received. But where responses are needed most - in many developing countries - they are fragile at best. The overall inability to act, owing to the cumulative effects of under investment and/or the lack of finance and insurance to undertake risk in a highly volatile world, is a cause for concern.

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[5] In its 2009 Trade and Development Report (UNCTAD, 2009), the United Nations Conference on Trade and Development (UNCTAD) contends that the massive inflow of fund money has caused commodity futures markets to fail the “efficient market” hypothesis, as the purchase and sale of commodity futures by swap dealers and index funds is entirely unrelated to market supply and demand fundamentals, but depends rather on the funds’ ability to attract subscribers.

It is unlikely that any of the factors alluded to above alone will trigger global crises. Looking back over history, low inventories on the part of major food exporters against climatic disturbances have tended to sow the seeds of crisis. The issue of climate change and other environmental pressures that test the resilience of agriculture are discussed in the following chapter.

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Chapter 4

Rising vulnerability in the global food system: environmental pressures and climate change[1]

Global Perspectives Unit (FAO) and Natural Resources Department (FAO)

This chapter extends the arguments made in Chapter 3 by examining the resilience of agriculture to cope with a changing climate in an already pressured ecological environment that will be subject to further demands. Recall that in the four decades leading to 2050, global food supply must rise 70 percent to meet the population's dietary needs, and that the increase needed in developing countries amounts to 100 percent. However, achieving food security for a rapidly-rising population is not the only factor behind the necessary growth. Agriculture will increasingly need to meet the demands of the emerging bio-based economy, especially in bioenergy and in markets for renewable and sustainable industrial products.

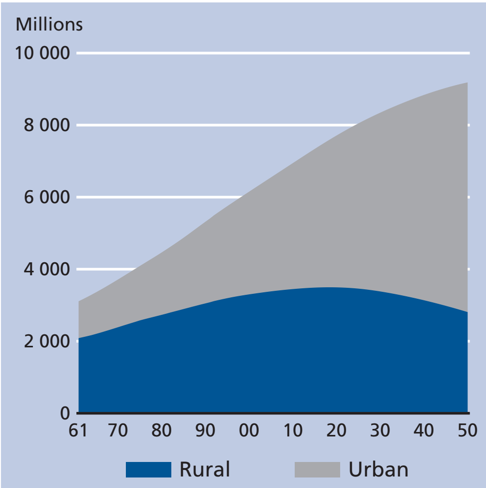
Both new and traditional demands for agricultural produce will put increased pressure on already-scarce agricultural resources. And while agriculture will be forced to compete for land and water with mushrooming urban settlements, it will also be required to serve on other major fronts: agriculture will have to adapt and contribute to the mitigation of climate change, help preserve natural habitats, protect endangered species and maintain a high level of biodiversity. If this were not challenging enough, in most regions fewer people will be living in rural areas, and even fewer will be farmers. They will need new technologies to grow more on less land, and with fewer hands.

The current momentum of rising agricultural production and productivity has been accompanied by adverse effects on the agricultural resource base, which have put its productive future potential in jeopardy. Among these effects are, for example, land degradation, salinization of irrigated areas, over-extraction of underground water, growing susceptibility to disease and build-up of pest resistance favoured by the spread of monocultures and the use of pesticides.

This backdrop of adverse effects and the observation that weather induced disturbances in major cereal producing countries have triggered past crises expose the growing fragility of the world's food production systems and agricultural markets to a changing climate. The pressures on agriculture are therefore immense. It seems that small deviations from the task of feeding more, that bring about scarcity through supply instability will lay the groundwork for further episodes of extreme volatility and crises.

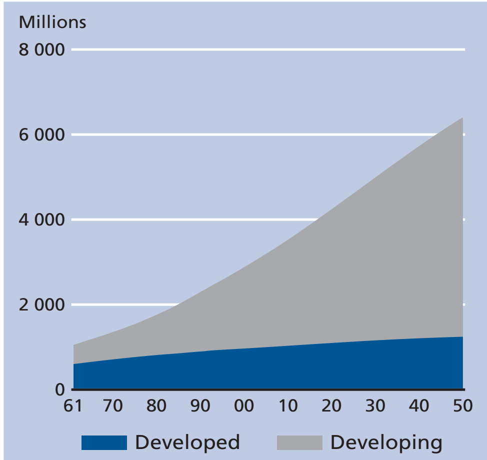
[1] This chapter is based on material from Bruinsma (2003), FAO (2009a) and FAO (2009b).

Figure 4.1: Population growth to 2050



Source: UN, FAO.

Figure 4.2: Urban population growth to 2050



Source: UN, FAO.

Vulnerability of the natural resource base

Demographic-induced vulnerability

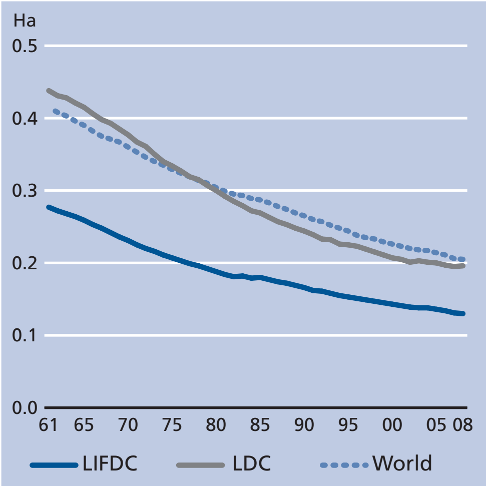
The exodus of rural inhabitants to towns and cities has resulted in a near explosion of urban populations. During 2008, the world's urban population was, for the first time, larger than the rural population. According to the latest UN forecasts, approximately 70 percent of the world's population is expected to reside in urban centres by 2050. Virtually all of this growth is foreseen to occur in developing countries, where, for instance, urban populations are expected to double over the next four decades and thus account for almost the entire increment in developing countries' population growth (Figure 4.1). But only part of this trend will be caused by increased rural-urban migration. Other reasons include the transformation of rural settlements into urban areas and, most importantly, natural urban population growth (Figure 4.2).

The process of urbanization does more than simply draw land resources away from food production. By lowering the pool of labour, urbanization has implications for agricultural wage levels and the composition of the remaining labour force. Typically the young, able-bodied, educated and skilled migrate, putting strain on current and future on-farm labour productivity.

In addition, such changes in population distribution will change the demand for fuel wood, especially charcoal, when incomes are insufficient to procure alternative sources of energy. Depletion of wood resources from areas supplying urban centres will results in major environmental problems such as soil erosion, soil infertility and danger of flooding. This trend is likely to persist during the decades to come unless alternative sources of energy are more widely available and accessible.

It is important to note that urban growth tends to occur on the best agricultural land. A 1987 estimate found that while 4 percent of potentially productive agricultural land would be lost to urbanization between 1975 and 2000, it would include a full quarter of the most productive land.

Figure 4.3: Per capita arable land availability (ha): 1961-2008



Source: UN, FAO.

Land-induced vulnerability

As populations grow, much good cropland is lost to urban and industrial development, roads and reservoirs. For sound historic and strategic reasons, most urban areas are situated on flat coastal plains or river valleys with fertile soils. Given that much future urban expansion will be centred on such areas, the loss of good-quality cropland seems likely to continue. In fact the losses seem inevitable, given the typically low economic returns to farm capital and labour compared with non-agricultural uses (Figure 4.3). Such losses are essentially irreversible, and in land-scarce countries the implications for food security could be serious.

Estimates of non-agricultural land use per thousand persons range from 22 ha in India (Katyal et al., 1997) to 15-28 ha in China (mainland) (Ash & Edmunds, 1998) and to 60 ha in the United States (Waggoner, 1994). The magnitude of future conversions of land for urban uses is not certain, nor is it clear how much of it will be good arable land. There is no doubt, however, that losses could be substantial. In China (mainland), for example, losses between 1985 and 1995 have been over 2 million ha, and the rate of loss to industrial construction has increased since 1980 (Ash & Edmunds, 1998).

Assuming that the conversion of land for non-agricultural purposes is an average of 40 ha per thousand persons, the projected loss on this account would be almost 90 million ha by 2050 (Table 4.1). Even if all of this land will have crop production potential, it still represents a fraction of the global balance of potential cropland that is as yet unused. However, in heavily populated countries such as China (mainland) and India that have very limited potential for cropland expansion, even small losses could be serious. In China (mainland), this issue has been of growing concern for a number of years.

Rising competition for land to pursue other economic activities poses a credible threat to the ability of food systems to meet allocative efficiency, especially for ensuring that supplies increase in response to high food price signals. The tenet of competitive markets is that the demand and supply of land will be governed by the economic returns to the factor of production. Notwithstanding the inelasticity of supply in the short run - land simply cannot

Table 4.1: Total arable land: data and projections

	Arable Land in Use						Annual Growth			Balance	
	1961/63	1989/91	2005	2005 adj.	2030	2050	1961-2005	1990-2005	2005-2050	2005	2050
	(mn ha)						(% p.a.)			(mn ha)	
sub-Saharan Africa	133	161	193	236	275	300	0.80	1.07	0.55	786	723
Latin America	105	150	164	203	234	255	1.01	0.64	0.52	861	809
Near East/North Africa	86	96	99	86	84	82	0.34	-0.02	-0.11	13	16
South Asia	191	204	205	206	211	212	0.15	0.07	0.07	14	7
East Asia	178	225	259	235	236	237	0.99	1.12	0.02	131	129
excluding China	73	94	102	105	109	112	0.85	0.71	0.15	78	75
Developing Countries	693	837	920	966	1040	1086	0.67	0.65	0.27	1 805	1 684
excl. China and India	426	536	594	666	740	789	0.75	0.66	0.39	1 730	1 609
Industrial countries	388	401	388	388	375	364	-0.02	-0.21	-0.15	486	510
World	1 375	1 521	1 562	1 602	1 648	1 673	0.30	0.17	0.10	2 576	2 503

Source: FAO.

be transformed from one productive activity to the next overnight - competition from the energy sector (namely biofuels and carbon sequestration) set aside for conservation and for rising urbanization as well as the building of new cities, can put the food sector on a poor competitive footing.

In many instances, however, the demand and supply of land for non-food activities is also being supported by policy mandates backed by subsidies and other incentives. Policy shifts that influence land utilization tend to be planned well in advance of their announcement and for the most part do not contribute to uncertainty. But their impacts do. Once resources are exhausted or degraded, little can be done.

A joint FAO-United Nations Environment Programme (UNEP) study has estimated the current extent of land degradation at 16 percent. Land degradation, which is a major threat to food security and has negated many of the productivity improvements of the past, is on the rise (Pimentel et al., 1995; UNEP, 1999; and Bremen et al., 2001).

Area of degraded land

The most comprehensive global assessment is the Global Assessment of Human-induced Soil Degradation (GLASOD) mapping exercise (Oldeman et al., 1991). The assessment is subject to a number of uncertainties, particularly regarding the impact of soil degradation on productivity, the rates of change in the area and the severity of degradation (Table 4.2).

There is no clear consensus about the area of degraded land, even at the national level. In India, for example, estimates by different public authorities vary from 53 to 239 million ha (Katyal et al., 1997). Land degradation is quite variable over small areas; owing to differences in soil type, topography, crop type and management practice impacts are highly site-specific. Some forms of degradation are not readily visible, e.g. soil compaction, acidification and reduced biological activity. Lack of data and analytical tools for measuring such differences prevents or limits estimation of their impact on productivity, and makes scaling up to the national or regional level problematic. Furthermore, there are no internationally-agreed criteria or procedures for estimating the severity of degradation. Few if any countries make systematic assessments at regular intervals that would help estimate the rates of change.

Table 4.2: Global assessment of human-induced soil degradation (GLASOD) million ha

Region	Total Land Affected	Percentage of Region Degraded	
		Moderate	Strong and Extreme
Africa	494	39	26
Asia	747	46	15
Australasia	103	4	2
South America	243	47	10
Central America	63	56	41
Europe	219	66	6
North America	96	81	1
Total	1 964	46	16

Source: FAO.

Impact of degradation on productivity

Does degradation have a serious impact on on-farm productivity and offsite environments through wind and water soil dispersal? Because degradation is normally a slow and almost invisible process, rising yields caused by higher inputs can mask the impact of degradation until yields are close to their ceiling. Yields thus hide the costs of falling input efficiency to farmers (Walker & Young, 1986; Bremen et al., 2001).

Water-induced vulnerability

A very small proportion the planet's water is available for human use (Table 4.3); around 2.5 percent of the world's water is fresh, and two-thirds of this is inaccessible (locked away in glaciers, and as snow, ice and permafrost) and much of the remainder is aquifer, leaving 0.4 percent of the world's total freshwater accessible on the surface (Evans, 2009). Global demand for water has risen sharply within the last century. At the beginning of the twentieth-century, each person used 350 m^3 of water on average per year. By 2000 this had risen to 642 m^3, while total annual water withdrawal rose from 579 to 3 973 km^3 over the same period. In the future, the impact of water stress and water scarcity is likely to grow significantly (*ibid.*).

One of the major questions concerning the future is whether there will be sufficient freshwater to satisfy the growing needs of agricultural and non-agricultural users. Agriculture already accounts for about 70 percent of the freshwater withdrawals in the world and is usually seen as the main factor behind the increasing global scarcity of freshwater.

Historically, irrigation has been crucial for gains in food production, either from productivity or from acreage. Irrigation reduces drought risk, encourages crop diversification and enhances rural incomes. An important step in estimating the pressure of irrigation on water resources is to assess irrigation water requirements and withdrawals. Precipitation provides part of the water crops need to satisfy their transpiration requirements. The soil, acting as a buffer, stores part of the precipitation water and returns it to the crops in times of deficit. In humid climates, this mechanism is usually sufficient to ensure satisfactory growth in rain-fed agriculture. In arid climates or during the dry season, irrigation is required to compensate for the deficit resulting from insufficient or erratic precipitation.

Table 4.3: Annual renewable water resources and irrigation water withdrawal: data and projections

	Precipi-tation	Renew-able water resources	Water use efficiency ratio		Irrigation water withdrawal		Pressure on water resources due to irrigation	
			2005/07	2050	2005/07	2050	2005/07	2050
	mm p.a	*cubic km*	*%*		*cubic km*		*%*	
Developing countries	990	28 000	44	47	2 115	2 413	8	9
sub-Saharan Africa	850	3500	22	25	55	87	2	2
Latin America & Carribbean	1530	13 500	35	35	181	253	1	2
Near East/North Africa	160	600	51	61	347	374	58	62
South Asia	1 050	2 300	54	57	819	906	36	39
East Asia	1 140	8 600	33	35	714	793	8	9
Developed countries	540	14 000	42	43	505	493	4	4
World	800	42 000	44	46	2 620	2 906	6	7

Source: FAO.

Accordingly, critical issues in water management have arisen in recent decades. These issues include: competition with the urban and industrial sectors for available water supply; poor irrigation water-use efficiency; over-extraction of groundwater; reduced infiltration of rainwater into soils and reduced water recharge because of deforestation and land degradation; declining crop yields and water quality related to waterlogging and salinization; contamination of groundwater and surface water from fertilizers, pesticides and animal wastes; and the risk of greater aridity and soil moisture deficits because of climate change.

Over-extraction

The over-extraction of groundwater is widespread in both developed and developing countries. It arises when industrial, domestic and agricultural withdrawals of water exceed the rate of natural recharge. In some areas, particularly in the Near East/North Africa region, irrigation draws on fossil aquifers that receive little or no recharge at a level that is not sustainable (Gleick, 1994). In many areas of China (mainland) and India, groundwater levels are falling by one to three metres per annum. The economic and environmental consequences are serious and will get worse in the absence of appropriate responses. Irreversible land subsidence, especially in urban and peri-urban areas, causes serious structural damage to buildings, drainage systems, etc. Over-extraction in coastal areas causes saltwater to intrude into freshwater aquifers, making them unfit for irrigation or drinking water without costly treatment. Lowering of the water table increases pumping costs. It will take many years to achieve the investments and other changes required to limit over-extraction, so several million ha of irrigated land may either go out of production or be faced with unsustainable operating costs.

Waterlogging and salinization

Irrigation mismanagement is often related to the problems of waterlogging and salinization. The former restricts plant growth. It arises from over-irrigation and inadequate drainage, and in many cases precedes salinization. Over ten million ha of land is estimated to be affected by waterlogging (Oldeman et al., 1991). Salinization results from the build-up of dissolved solids in soil and soil water, and can occur in rain-fed areas with inherently susceptible soils (e.g. parts of Australia) as well as in irrigated areas. The UNEP considers salinization to be the second largest cause of land loss. Estimated impacts, however, vary considerably. Oldeman et al. estimate the total affected area to be over 76 million ha. It seems possible that some 20 percent of total irrigated area is affected, and some 12 million ha of irrigated land may have gone out of production (Nelson & Mareida, 2001).

In some semi-arid countries, 10 to 50 percent of the irrigated area is affected to a greater or lesser degree (Umali, 1993; FAO, 1997b and FAO, 1997a) with average yield decreases of 10 to 25 percent for many crops (FAO, 1993; Umali, 1993). Unfortunately there are little or no time series data to allow reliable estimates of the rates of change in the salinized area. It could be 1-1.5 million ha per annum and increasing (Umali, 1993), but this is difficult to quantify. Of particular concern are those irrigated areas in semi-arid regions that support large rural populations, such as the western Punjab and Indus valley where large areas of waterlogged saline land are spreading through the intensively irrigated plains.

Climate change

Climate change magnifies the threat to food security by increasing the frequency of climate hazards, diminishing agricultural yields and production in vulnerable regions and increasing water scarcity. The potential for intensifying conflicts over even more scarce resources will likely lead to new humanitarian crises, as well as increased urbanization, migration and displacement (IPCC, 2007).

At the same time, local production declines will significantly impact the income opportunities and the purchasing power of developing countries. Worldwide, 36 percent of the total workforce - two-thirds in sub-Saharan Africa - is employed in agriculture and depends on productivity growth within smallholder agriculture to improve their incomes and food security (FAO, 2009b). Low-income countries with limited financial capacity to trade, high dependence on their own production to cover food requirements, and high-demand growth are hence likely to face difficulties in ensuring that their populations will have access to food that will be available on global markets (*ibid.*).

Climate change is also likely to affect the utilization of food. Decreasing availability of food and water, high food prices, as well as more frequent extreme natural events will increase malnutrition. Diseases may spread to geographical areas where they have not previously been. This could initiate a vicious circle where infectious diseases, including water-borne diseases, cause or compound hunger, which in turn makes the affected population more susceptible to those diseases. Malnutrition and illness lead to declining labour productivity and incomes.

The IPCC fourth assessment report

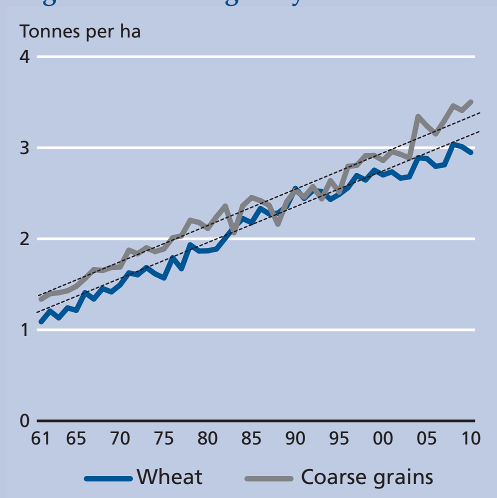
The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report provides the latest model-based projections and indicates that in the “best-case scenario” average surface air temperatures could rise by 1.8 °C (with a likely range of 1.1 to 2.9 °C) and sea level

Box 4.1: Do volatile crop yields portend climate change?

Average global yields of major grain crops have been particularly variable in recent years, as predicted by most climate-change impact models. It has also been predicted that greater weather variability will be one of the first signs of changing overall climatic conditions. However, when yields are further dissected into changes in individual countries and types of cereals, two interesting developments become clear.

First, the above-trend growth for grains as a whole is generally owed to exceptionally high yields for coarse grains and particularly rapid growth in maize yields in higher-latitude production systems. While it is too early to ascribe these changes to climate change, the observed effect is in line with the predictions under most climate change scenarios that foresee yield increase for temperate zone crops (higher latitudes). The expected changes in agro-ecological growing conditions (higher temperatures, increased average precipitation and CO2 fertilization) would suggest that higher average yields may remain a feature for the first decades of the twenty-first century. Second, a further differentiation between wheat and coarse grains reveals that wheat yields have become both lower on average and more variable across countries and years.

Figure 4.4 Global grain yields: 1961-2010



Source: Adapted from Schmidhuber (2006).

rise likely range (18 to 38 cm). On the other hand, in the "worst case scenario", temperatures could rise by 4.0 °C (with a likely range of 2.4 to 6.4 °C) and sea level rise likely range (26 to 59 cm).

Agricultural impacts, for example, will be more adverse in tropical areas than in temperate areas. Developed countries will largely benefit as cereal productivity is projected to rise in Canada, northern Europe and parts of the Russian Federation. In contrast, many of today's poorest developing countries are likely to be negatively affected in the upcoming decades owing to a reduction in the extent and potential productivity of cropland. Most

Box 4.2: The IPCC Fourth Assessment Report

The latest key findings of the IPCC regarding current research results on the state of climate change, its drivers and projections for the future include but are not limited to the following highlights (IPCC, 2007a):

- Warming of the climate system is now unequivocal
- The rate of warming in the last century is historically high
- The net effect of human activities since 1750 has been one of warming, due primarily to fossil fuel use, land-use change and agriculture;
- Most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely (greater than 90 percent) owing to the observed increase in anthropogenic greenhouse gas emissions
- Long-term changes in climate have already been observed, including changes in Arctic temperature and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and intensity of tropical cyclones leading to food supply disruption
- From 1900 to 2005, drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia
- Increased heat stress to crop and livestock; e.g. higher night-time temperatures, which could adversely affect grain formation and other aspects of crop development
- Increased evapo-transpiration rates caused by higher temperatures and lower soil moisture levels
- Concentration of rainfall into a smaller number of rainy events with increases in the number of days with heavy rain, increasing erosion and flood risks
- More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics
- Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the twenty-first century that will very likely be larger than those changes observed in the twentieth century
- Projections for the twenty-first century include a greater chance that more areas will be affected by drought, that intense tropical cyclone activity will increase, that the incidence of extreme high sea levels will increase (aggravated by subsidence in parts of some densely populated flood-prone countries, displacing millions) and that heat waves and heavy precipitation events will be more frequent
- Even if greenhouse gas concentrations were to be stabilized, anthropogenic warming and sea-level rise would continue for centuries owing to the timescales associated with climate processes and feedbacks.

severely affected will be sub-Saharan Africa owing to its inability to adequately adapt through necessary resources or greater food imports.

Problems facing farmers can be better understood if one considers the impact of climate change on weather or water. Precipitation, temperature and sunlight are the main factors behind agricultural production. Climate change can alter these factors and cause essential threats to water availability, reduce agricultural productivity, spread vector borne diseases to new areas and increase flooding from sea level rise and even heavier rainfall.

The IPCC Fourth Assessment Report addresses food security by discussing the foreseeable impacts on agricultural productivity and production in different regions around the globe. The report's collective comments suggest that some areas will benefit from global warming, at least during a transitional period, though most will be adversely affected. Significantly, the assessment emphasizes that those areas that will benefit from global warming in the near to mid-term will eventually also suffer from declining productivity. Various parts of the assessment also reference changes in the hydrological cycle that will affect agriculture in general and food security specifically.

Migrations forced by climate change (for example, excessive heat, increased evaporation rates, or prolonged drought-induced crop failures or flood) will further burden the already-stretched agricultural resources and food supplies of regions that have managed to sustain productivity.

According to an FAO study, a projected 2 to 3 percent reduction in African cereal production by 2020 is enough to put ten million people at risk. These impacts would require adaptation efforts that in many cases will hardly be affordable for people living with little access to the necessary resources or savings. In fact, the real impact will be in areas where food production is already marginal.

Aspects of vulnerability

About 25 years ago, a schematic diagram as shown in Figure 4.10 presented an idealized picture of a food production system where weather affects only crop yields. However, even at that time, the true impact of weather on many commodities was already well known.

The broader influence of weather is suggested in another version of the graph (Figure 4.11) where the box previously marked “weather” is replaced by “drought”. In fact, lines in Figure 4.11 can be drawn from the drought box to many of the boxes in the diagram - even the “tastes” box - as humanitarian food imports of wheat or yellow maize, which, though not a staple in certain food importing regions, has been known to distort local food preferences. This situation has led to arable land being removed from traditional crop cultivation and given to the cultivation of non-traditional, climate-sensitive food crops.

In addition to what is already known or what will likely be the impact of episodes of extreme weather and climate on food production and, therefore, on food security, it is reasonable to speculate on the major impacts that might accompany global warming. In truth, such speculation has already been happening for several decades. The most legitimate assumption is that every box in the above graphic will be affected if the weather box were replaced by a “global warming” box.

Vulnerability patterns

Vulnerability is generally defined as a function of risk and exposure. Vulnerability with regard to climate change implies that people are exposed to aspects of climate that are changing in ways that will either generate or increase risk, which generally implies a potential loss of something valued.

For food security, there is higher risk of poorer nutrition or reduced access to food supplies than would be expected under “normal” climate conditions. The capacity to cope with the risky situations under a given exposure to hazards (both natural and human-induced) also shapes the pattern of vulnerability. As often is the case, this capacity is weak in parts of the world that suffer from food insecurity either intermittently or chronically.

Box 4.3: Modelling climate change impacts on regional agriculture: production

Climate change simulations are inherently uncertain. Two climate models - the National Centre for Atmospheric Research, the United States of America (NCAR) and the Commonwealth Scientific and Industrial Research Organization, Australia (CSIRO) - both of which apply the A2 scenario of the IPCC Fourth Assessment Report (temperature rise of 3.4 °C with a likely range of 2.0 to 5.4 °C), have been used to simulate future climate. The "wetter" NCAR scenario foresees average precipitation increases on land of about 10 percent, whereas the "drier" CSIRO scenario sees increases of about 2 percent.

Figure 4.5 Wheat production: climate change impacts

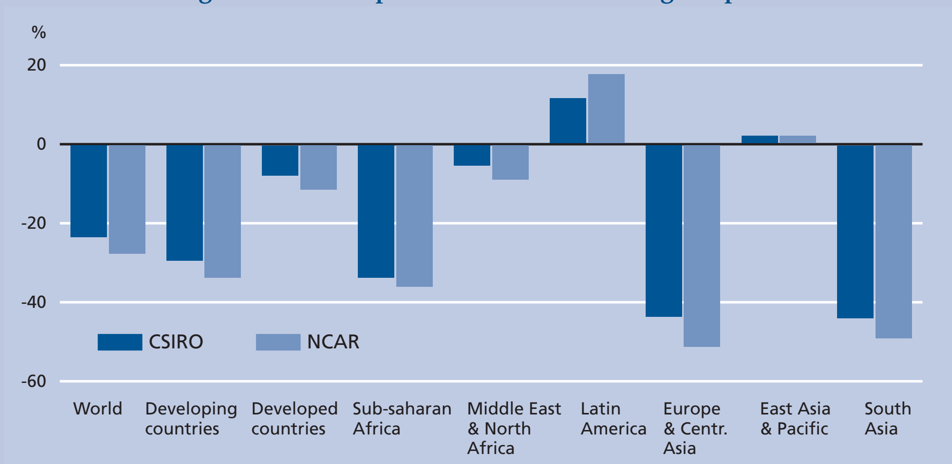


Figure 4.6 Maize production: climate change impacts

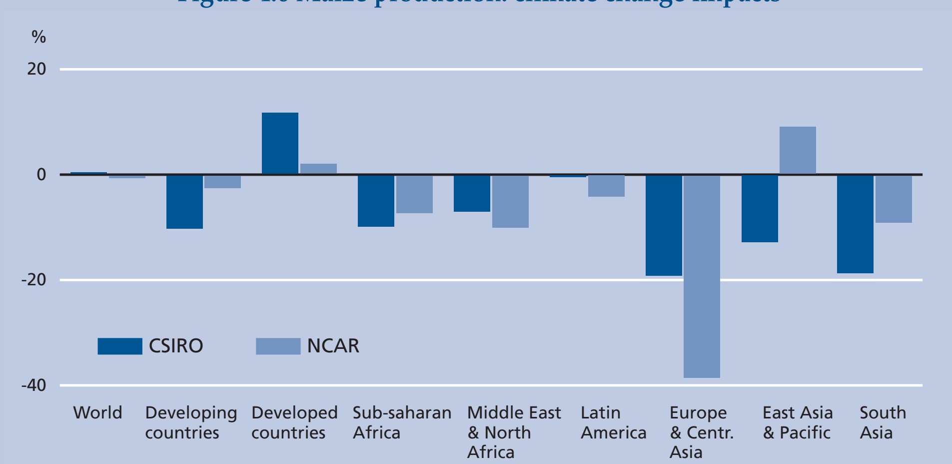
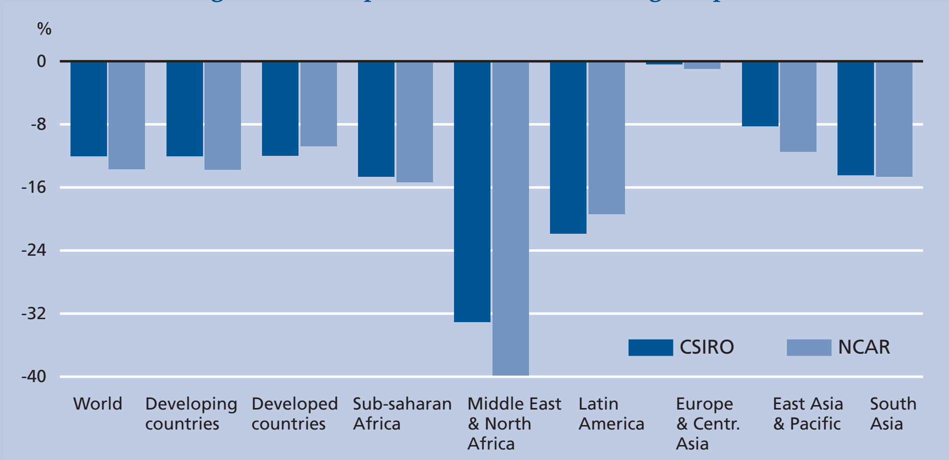


Figure 4.7 Rice production: climate change impacts



According to both models, in the case of no climate change, the production of all major crops will increase in developing countries. For example, in developing countries, production of rice increases by 17 percent, wheat by 76 percent and maize by 73 percent. Climate change reverses much of this increase, with the extent of the change depending on the region, crop and climate model. For example, in South Asia, maize production increases by 15 percent with no climate change, but is 9 percent below that level in the NCAR scenario and 19 percent below in the CSIRO scenario. In sub-Saharan Africa, maize production increases by 45 percent without climate change, but is 10 percent below that level with the CSIRO scenario and 7 percent lower with the NCAR.
Source: Nelson et al. (2009).

Rates and processes of change

Some of the most important factors of climate change are the expected shifts in the rates at which rainfall, temperature, relative humidity, cloudiness, evapo-transpiration (the process by which moisture is exchanged between the atmosphere and vegetation and soils) occurs. If the rates change incrementally and societies are aware of them, those societies may be able to adjust human activities accordingly. Within limits, some ecosystems will also likely be able to adjust to incremental changes. If, however, the rates of change are too rapid to be viable for adjustments such as shifting agricultural practices, changing crop rotations, developing new fodder regimes for livestock as grasslands dry out, then societies will be unable to escape with minimal impacts to their climate-sensitive activities and to the ecosystems on which those activities depend.

Virtual water and ghost acres

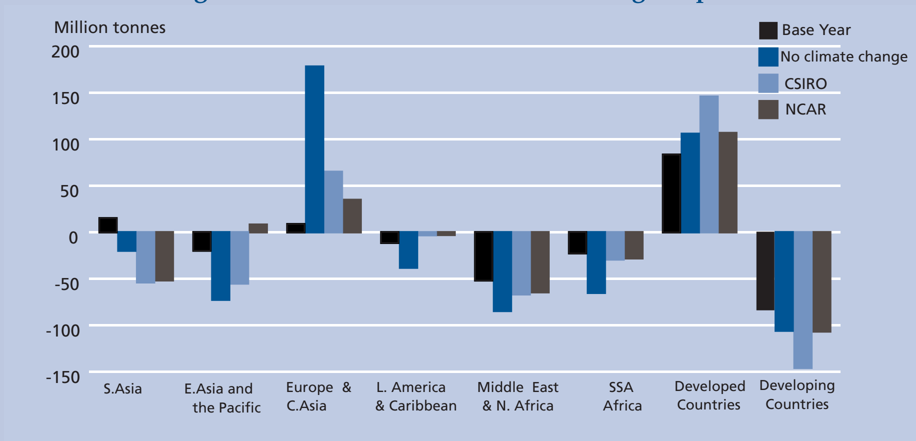
All reports on the hydrologic cycle suggest that it will intensify as the atmosphere warms, with some suggesting that the cycle could yield about 15 percent more precipitation per annum. At this point, however, conjectures based on global circulation model output are

[1] Originally from Morton (2007).

Box 4.4: Modelling climate change impacts on regional agriculture: trade

Regarding trade, under a no climate change situation, developed-country net exports increase from 83.4 mmt to 105.8 mmt between 2000 and 2050; an increase of 27 percent. Developing-country net imports mirror this change. With the NCAR results and no CO2 fertilization, developed-country net exports increase slightly (0.9 mmt) over no climate change. With the drier CSIRO scenario, on the other hand, developed-country net exports increase by 39.9 mmt

Figure 4.8 Cereal net-trade: climate change impacts



Regional results show (see above figure) important differences in the effects of climate change on trade and the differential effects of the three scenarios. For example, in 2000 South Asia is a small net exporter, and will become a net importer of cereals in 2050 with no climate change. Both scenarios result in substantial increases in South Asian net imports relative to no climate change. The East Asia and Pacific region is a net-importing region in 2000, and imports grow substantially with no climate change.

Depending on climate change scenario, this region has either slightly less net imports than with the no climate change scenario or becomes a net exporter. In Latin America and the Caribbean, the 2050 no climate change scenario shows increased imports relative to 2000, but both the CSIRO and NCAR climate scenarios result in smaller net imports in 2050 than in 2000.

Source: Nelson et al. (2009).

little more than speculation and educated guesses, not yet reliable enough to predict with any accuracy where the precipitation would fall, how it might fall, or when it will fall. Paradoxically, these reports also suggest that water scarcity in the next couple of decades is highly probable, with extreme shortages already appearing in various locations around the globe. As changes to the global water cycle become more pressing, policy-makers will have to scrutinize more closely where their limited water supplies will go and what they will be used for. The concepts of virtual water will become more and more relevant as these cycles continue to change.

Box 4.5: Climate impacts on food prices

Although the various climate change scenarios differ with regard to population and policy assumptions, most development paths essentially describe a world of robust economic growth and foresee real incomes rising more rapidly than real food prices. This suggests that the share of income spent on food should decline and that higher food prices are unlikely to create a major dent in the food expenditures of the poor. However, not all parts of the world perform equally well in the various development paths and not all development paths are equally benign for growth. Where income levels are low and shares of food expenditures are high, higher prices for food may still create or exacerbate a possible food security problem. A number of studies have measured the likely impacts of climate change on food prices (e.g. Fischer et al., 2002; Tubiello et al., 2006). The basic messages that emerge from these studies are:

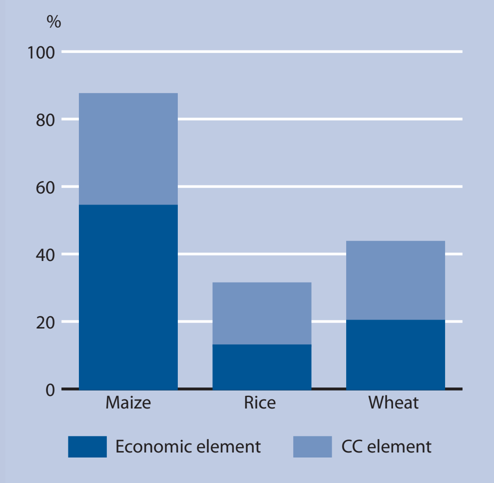
- On average, food prices are expected to rise moderately in line with moderate increases of temperature until 2050. After 2050 and with further increases in temperatures, prices are expected to increase more substantially.
- Expected price changes from the effects of global warming are, on average, much smaller than the expected price changes from socioeconomic development paths. For instance, in one scenario would imply a price increase in real cereal prices by about 170 percent.

Table 4.4 Climate change scenario impacts on food prices

	% price change, 2010 mean to 2050 mean		
	Maize	Rice	Wheat
Baseline	100.7	54.8	54.2
	(24.6; 0.104)	(4.2; 0.011)	(14.0; 0.060)
Optimistic	87.3	31.2	43.5
	(25.4; 0.114)	(2.0; 0.006)	(13.8; 0.063)
Pessimistic	106.3	78.1	58.8
	(25.5; 0.109)	(4.3; 0.010)	(15.3; 0.065)
	% price change, 2050 perfect mitigation to 2050 CC		
	Maize	Rice	Wheat
Baseline	32.2	19.8	23.1
Optimistic	33.1	18.4	23.4
Pessimistic	34.1	19.5	24.4

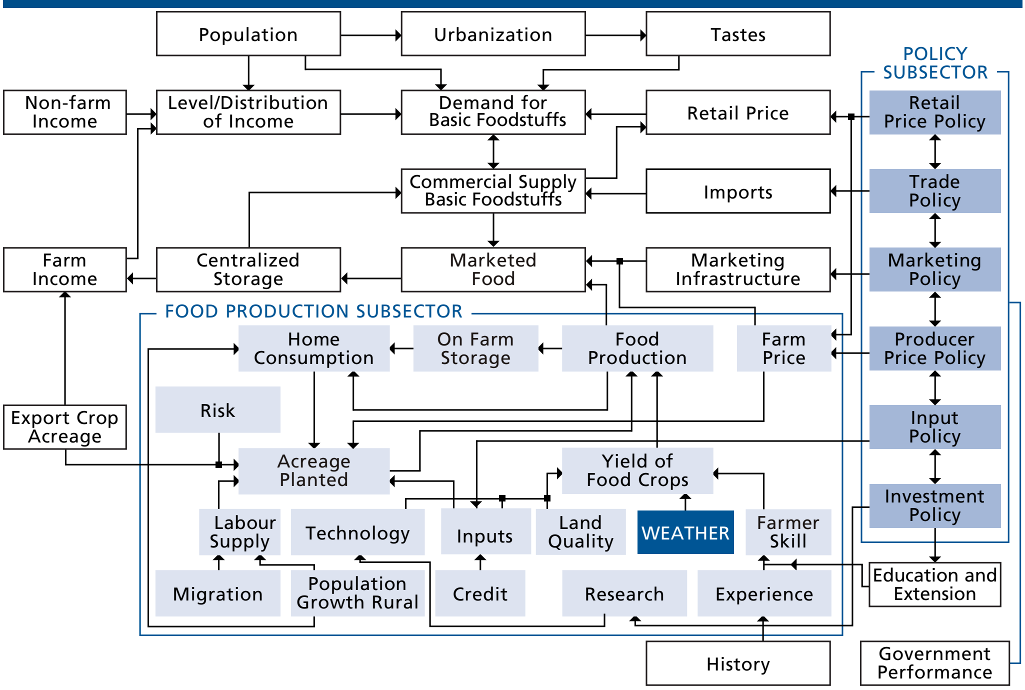
The additional price increase as a result of climate change would only be 14.4 percent. Overall, this appears to be the sharpest price increase reported and it is not surprising that this scenario would imply a persistently high number of undernourished people until 2080. Recently, Nelson et al. (2010), using scenario analysis based on four climate change models, found that relative to a world with perfect mitigation, prices in 2050 with climate change are higher by 18.4 percent (optimistic for rice) to 34.1 percent (pessimistic for maize). The authors' results are shown in the table above and the figure below(optimistic scenario only).

Figure 4.9 Percentage change in cereal prices (optimistic CC scenario)



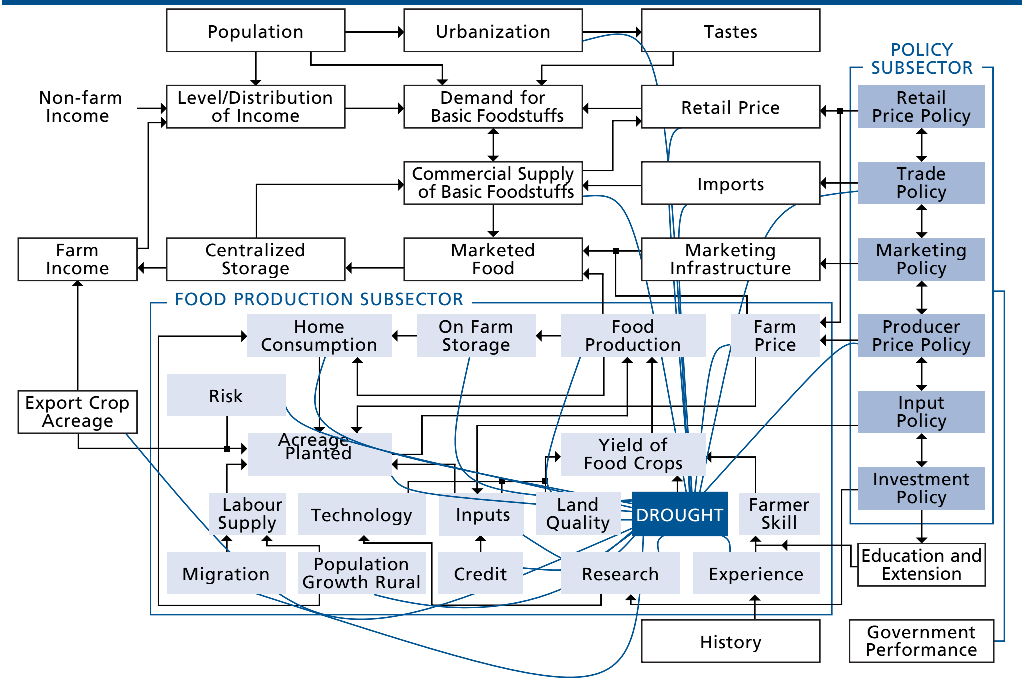
Source: Nelson et al. (2010).

Figure 4.10: An idealized food system



Source: Glantz (1987).

Figure 4.11: A food system under drought



Source: Adapted from Glantz (1987).

Similarly, the concept of ghost acres (or ghost hectares) was developed several decades ago. It was used to explain that food imports by Country A relied for those imports on the agricultural lands of Country B. In the same way, the "Green Revolution" also provided ghost acres in that the use of fertilizers and irrigation enhanced agricultural productivity and overall production from beyond what the land might have been able to provide in its natural state (Lang & Heasman, 2004). A country such as Japan, for example, would require several times more farmland than it has in order to produce an equivalent amount of protein to replace the amount it takes from the sea. The notion of ghost acres also applies to a country's food imports.

Global warming and disappearing seasons

The disappearance or even substantial changes in the overall characteristics of seasons is a concern. The problem is that over the past few decades, winters have generally become drier and warmer in many regions. Rainy seasons have become less so, not abruptly but incrementally over time. Both industrialized as well as developing economies and economies in transition live by the expected flow of the seasons, so no country will escape changes in seasonality with a warming atmosphere. Such changes will affect human settlements worldwide in ways that most communities are just beginning to consider. For example, researchers predict chronic water shortages worldwide (as in the eastern part of the Democratic Republic of the Congo), a shifting boundary between rangeland and farmland, recurrent and prolonged drought (as in various parts of sub-Saharan Africa, Australia and the southeast of the United States of America), a potential increase in the number and frequency

Box 4.6: The impacts of climate change on smallholder and subsistence agriculture

Although there has been much recent public discussion about the effects of climate change on rural areas of developing countries, not much of it has engaged with either the science of climate change impact on agriculture or the specificities of smallholder and subsistence systems.

Impacts on these systems should be considered in terms of hard-to-predict compound impacts highly specific to location and livelihood systems in different ecosystems and regions of the world. These livelihood systems are typically complex; they involve a number of crop and livestock species, between which there are interactions-for example, intercropping practices or the use of draught animal power for cultivation, and potential substitutions such as alternative crops.

Many smallholder livelihoods also include use of wild resources and non-agricultural strategies such as remittances. Coping strategies for extreme climatic events such as drought typically involve changes in the relative importance of crops, livestock species and non-agricultural activities, and the interactions between them. Positive and negative impacts on different crops may occur in the same farming system. Impacts on maize - the main food crop - will be strongly negative for the Tanzanian smallholder, whereas impacts on coffee and cotton - significant cash crops - may be positive.

There is evidence of increased risk of crop pests and diseases of crops under climate change, although knowledge of likely impacts in the tropics and on smallholder systems is much less developed. Modelling responses of both pathogens and (where relevant) insect vectors to rising temperatures and changing precipitation is complex, but there is cause for concern over possible spread of major diseases that attack smallholder crops in Africa: for example, Maize Streak Virus and Cassava Mosaic Virus in areas where rainfall increases, and sorghum head smut (a fungal disease) in areas where rainfall decreases. The latter would be compounded by farmers switching adaptively to sorghum in areas where maize becomes marginal. For diseases of livestock, modelling studies suggest overall slight declines in habitat suitable for tsetse-transmitted trypanosomiasis and East Coast Fever, although effects will be localized. Increased frequency of floods may increase outbreaks of epizootic diseases such as Rift Valley Fever and African Horse Sickness.

Another class of impacts is felt at the level of communities, landscapes and watersheds and has been less considered in literature on climate change and agriculture, although there is some overlap with consideration given to extreme events. One such impact is the effects of decreasing snowcaps on major irrigation systems involving hundreds of millions of smallholders, particularly in the Indo-Gangetic plain. As a result of warming, less precipitation falling as snow and earlier spring melting, there will be a shift in peak water supply to winter and early spring and away from the summer months when irrigation is most needed, with likely severe effects in areas where storage capacity cannot be expanded. Combined with increased water demand and the pre-existing vulnerability of many poorer irrigated farmers, such an impact could be catastrophic. Climate change effects on soil fertility and water-holding properties will also be important. Global warming and accompanying hydrological changes are likely to affect all soil processes in complex ways, including accelerated decomposition of organic matter and depression of nitrogen-fixing activity, resulting in increased soil erosion worldwide.

Source: Tubiello et al. (2008) – originally from Morton (2007).

of famines and perhaps a shift in their locations, and a shortening or lengthening of local and regional hazards related to climate, water and weather.

Forecasting by analogy: the future is here for those who wish to see it

Many of the adverse climate-change-related environmental scenarios being discussed, especially regarding the consequences of future human interactions with various types of ecosystems, from deserts (i.e. desertification) to mountain slopes (i.e. deforestation), have already been occurring for decades. Such scenarios should, therefore, no longer be viewed as speculation because the impacts of those changes have already been demonstrated, if not within one country, then in another. Even where there is a paucity of data for one particular area, the results of similar modifications to the natural environment have already been tracked and tested in other areas, yielding results that have demonstrated these modifications as being either good or bad for the environment, for society, or for both. Such correlations are at the heart of “forecasting by analogy”.

The deforestation of mountain slopes, for example, will likely yield results in remaining forested mountain areas that are similar to those that have been witnessed in areas where such degradation has already taken place; in other words, the experiment of mountain slope deforestation has already been performed and the results are in hand, at least as far as the long-term impacts on the natural environment are concerned. When similar approaches to mountain forest management are attempted anew in a similar topographical setting elsewhere on the globe, therefore, similar results - soil erosion, rapid rainfall runoff, lower soil moisture recharge, sediment loading of streams, dams and reservoirs, faster snowmelt in the spring - should be expected.

Prolonged dry spells and especially-severe droughts expose inappropriate land use practices of farmers and herders; that is, practices that are inappropriate during periods of moisture stress but that are hidden or tolerated by nature during periods of favourable rainfall. A similar situation is likely to occur with regard to climate change, as the various characteristics of climate intensify or shift to locations where they had not been witnessed before. Policy-makers and individuals alike need to be alert to subtle changes in the environment or in the human interface with climate-sensitive ecosystems. It is also important to be aware that severe droughts can expose unsustainable land management practices.

The process of forecasting by analogy is valid when considering scenarios for other ecosystems, like the destruction of mangrove forests for the development of shrimp ponds or the irrigation of soils in arid areas without putting proper drainage facilities in place. While some governments have made sustainable changes to their environments, others have not. The point is that “new” scientific assessments of potential environmental impacts for each and every human interaction with the environment are often not necessary because the impacts of most human-induced environmental changes have already been sufficiently demonstrated.

Creeping environmental change

Quick-onset changes in climate and the environment are easy to see but difficult to cope with. Slow-onset changes, on the other hand, are difficult to see and even more difficult to cope with, at least in a timely way. Crop failure owing to drought occurs over a short period of time and is obvious to the observer. Decline in crop yield, however, is more readily detected over a longer time period. Governments in general tend to have considerable difficulty dealing with slow-onset, low-grade but cumulative changes to the environment.

The same holds true for similar creeping changes in both managed and unmanaged ecosystems as well as for changes in various aspects of climate, including subtle changes in temperature, rainfall, inter-annual variability, record-setting anomalies and so forth. Governments need to spend more attention coping with creeping changes in climate, water and weather because those incremental creeping changes eventually accumulate, leading to crises at some time in the future. For example, "famine" can be viewed as either an event or a process. Perceived as an event, famine is usually identified, on the one hand, in terms of the number of people forced to seek food in refugee camps. As a process, on the other hand, famine is identified by indicators of progress (change) that constitute subtle indicators along the path toward famine, such as increased sales of personal property, the drastic forced thinning of herds and unfavourable market behaviour of land, livestock, credit and water - each of which works against the scarce resources of poor farmers and herders.

Creeping changes, by their very nature, accumulate and eventually become major changes that usually materialize in environmental crises that interact with - if not create - other creeping environmental changes. For example, deforestation of mountain slopes can lead to soil erosion and increased runoff during heavy rains, intensifying the turbidity loads of rivers and streams. This silt continues to build up until it settles in reservoirs and behind dams, decreasing their utility and shortening their expected lifespan. This situation, in turn, reduces the amount of water that the dam or reservoir can provide to downstream users, while the increased runoff can lead to more serious and more frequent flooding of settlements and cultivated areas.

Summary

In summary, climate change multiplies existing threats and at the same time increases the vulnerability of individuals, communities and countries to food insecurity. Accelerated degradation of natural resources, coupled with more extreme weather events and growing food prices will further deplete the productive assets and income opportunities of the poor (World Bank, 2010). This reduces rural households' ability to produce or buy food as well as to recover from and build resilience to shocks, creating a downward spiral of eroding resilience.

Climate change may affect the physical availability of food production through shifts in temperature and rainfall; people's access to food by lowering their incomes from coastal fishing because of rising sea levels; or lowering a country's foreign exchange earnings by the destruction of its export crops because of the rising frequency and intensity of tropical cyclones. Some groups are particularly vulnerable to climate change: low-income groups in drought-prone areas with poor infrastructure and market distribution systems; low to medium-income groups in flood-prone areas who may lose stored food or assets; farmers who may have their land damaged or submerged by a rise in sea level; and fishers who may lose their catch to shifted water currents or through flooded spawning areas.

Other than foreseeing higher prices, current global assessments of climate change have been unable to quantify the likely climate change effects on price volatility. The main drivers of climate change induced price volatility would stem from impacts of extreme events such as drought and floods. That is, they have not considered the possibility of significant shifts in the frequency of extreme events on regional production potential, nor have they considered scenarios of abrupt climate or socioeconomic change and the upheaval cause by shifting production and trade zones. Such scenario variants are likely to significantly increase the already negative projected impacts of climate change on world food supplies (Tubiello et al., 2008).

Changing climatic conditions and degraded agri-environments are projected to adversely affect food systems on all scales, from a single household to the global level. It is essential for policy-makers to address the fundamental question of how to increase the resilience of present food production systems to the challenges posed by climate change.

To rephrase Evans (2009), do the issues discussed above imply, then, that humanity is inevitably heading for a Malthusian scenario as global population rises towards ten billion persons? The answer is a probable no. Looking back, history shows that a rapid escalation in population growth has always been accompanied by innovation, such as the "green revolution". However, the twinning of trends that point to supply scarcity with the demands of an ever-rising world population makes for a highly precarious situation that is full of uncertainty. Therefore, global solutions need to start with the clear recognition of that risk.

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Chapter 5

The nature and determinants of volatility in agricultural prices: an empirical study

Kelvin Balcombe[1]

The purpose of this chapter is to provide empirical support for the discussions in Chapters 3 and 4 that hypothesize determinants of price volatility, and to explore how the nature of volatility has evolved over the past few decades as demonstrated by the prices of 19 internationally-traded agricultural commodities.

In short, all of the price series are found to exhibit persistence in volatility (periods of relatively sustained high and low volatility). There is also strong evidence of transmission of volatilities across prices. Volatility in crude oil prices is found to be a significant determinant of volatilities in the majority of series and, likewise, the exchange rate volatility is found to be a volatility predictor in over half of the series. There is also strong evidence that stock levels and yields influence price volatility. Most series exhibit significant evidence of volatility trends. However, there is an upward direction for some series and a downward direction for others. Thus, there is no general finding of long-term volatility increases across all agricultural prices.

Background

Chapter 1 of this book empirically shows that the volatility in agricultural prices has changed over the recent decade, especially for three commodities key for food security: wheat, maize and soybeans. As discussed there, increasing volatility is a concern for agricultural producers as well as for other agents along the food chain. Price volatility can have a long-run impact on the incomes of many producers and the trading positions of countries, and can make planning production more difficult. Higher volatility results in an overall welfare loss (Aizeman & Pinto, 2005), though there may be some who benefit from higher volatility. Moreover, adequate mechanisms to reduce or manage risk to producers do not exist in many developing countries, and thus expose themselves to overall vulnerability. Therefore, an understanding the nature of volatility is required to mitigate its effects, particularly in developing countries, and further empirical work is needed to enhance our current understanding. In view of this need, this chapter seeks to study the volatility of a wide range of agricultural prices.

Importantly, the primary aim of studying volatility is not to trace the trajectory of the series itself or the determinants of its directional movements, but rather to describe the

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determinants of the absolute or squared changes in the agricultural prices.[2] I approach this problem from two directions: first, by directly measuring the volatility of the series and regressing it against a set of variables such as stocks, past volatility, etc.; and second, by modelling the behaviour of the series while examining whether the shock variances that drive price evolution can be explained by past volatility and other key variables.

More specifically, I employ two econometric methods to explore the nature and causes of volatility in agricultural price commodities over time. The first decomposes each of the price series into components and examines the volatility for each. Using this approach I examine whether volatility in each price series is predictable, and whether it is dependent on: stocks; yields; export concentration; the volatility of other prices including oil prices, exchange rates and interest rates. This first approach will be used to analyse monthly prices.[3] The second uses a panel regression approach whereby volatility is explained by a number of key variables. This approach has a drawback, however, as several of these key variables - notably inventories and yields - are only observed at the annual frequency, limiting the sample size and masking the intra-year variability of the series.

On a methodological level, our strategy differs from previous work in this area by its treatment of the variation in volatility of both trends and cyclical components (should a series contain both) of the series. Previous work has tended to focus on either one or the other. Alternatively, studies that have used a decomposed approach have not employed the same decomposition as is done here. Importantly, in contrast to many other approaches, the framework I use to analyse monthly data requires no prior decision about whether the series contains trends.

Modelling volatility processes

While the volatility of a time series may seem like a rather obvious concept, there are in fact several different potential measures of a series' volatility. For example, if a price series has a mean,[4] then the volatility may be interpreted as its tendency to have values very far from this mean. Alternatively, volatility may be interpreted as a series' tendency for large changes in its values from period to period. A high rate of volatility according to the first measure need not imply a high volatility according to the second. Another commonly held notion is that volatility is defined in terms of the degree of forecast error. A series may have large period-to-period changes, or large variations away from its mean, but if the conditional mean of the series is able to explain most of the variance, then a series may not be considered volatile.[5] Thus, a universal measure of what seems to be a simple concept is in fact quite elusive. Where series contain trends, an appropriate measure of volatility can be even harder to define. This is because the mean and variance (and other moments) of the data-generating process do not technically exist. Methods that rely on sample measures can therefore be misleading.

Shifts in volatility can come in at least two forms: First, an overall permanent change (whether a gradual shift or a break) in the volatility of the series; and, second in a "periodic" or "conditional" form whereby the series appears to have periods of relative calm and others

2 In order to model volatility, it may be necessary to model the trajectory of the series. However, this is a necessary step rather than an aim in itself.

3 Data of varying frequencies are used not for theoretical reasons, but owing to availability. The data were provided by FAO.

4 That is, the underlying data-generating process has a mean, not just the data, in the sample.

5 This definition is embodied in the notion of "implied volatility", whereby futures or options prices relative to spot prices are used to measure volatility.

of high volatility. The existence of the periodic form of volatility is now empirically well-established for many economic series. Speculative behaviour is sometimes seen as a primary source of changeable volatility in financial series. The vast majority of the evidence for periodic changes in volatility is in markets where there is a high degree of speculation. This behaviour is particularly evident in stocks, bonds, options and futures prices. For example, booms and crashes in stock markets are almost certainly exacerbated by temporary increases in volatility.

While there is less empirical evidence about volatility changes in agricultural commodity markets, there is nonetheless some strong empirical evidence that this is the case. Moreover, there are good *a priori* reasons to think that changes in volatility might exist. For example, Deaton and Laroque's models (Deaton & Laroque, 1992) based on the theories of competitive storage suggest, *inter alia*, that variations in price volatility should exist. Moreover, market traders to some extent act in a similar way to the agents that determine financial series. They are required to buy and sell according to fluctuating conditions and there is money to be made by buying and selling at the right time. However, agricultural commodity prices are different from most financial series owing to the fact that both their of production and stock levels are likely to be an important factor in determining their prices (and the volatility of these prices) at a given time. The connectedness of agricultural markets to other markets experiencing volatility variation (such as energy) may also influence the volatility of agricultural commodities.

For a series with a stable mean value over time (mean reverting[6]), the variance of that series would seem to be an obvious statistic to describes its *ex ante* (forward looking) volatility.[7] More generally, if a series can be decomposed into components such as trend and cycle, the variance of each can describe the volatility of the series. The use of the term *ex ante* requires emphasis, because clearly a price series can have relatively large or small deviations from its mean without implying a shift in its overall variability. It is important to distinguish *ex ante* from *ex post* (historical or backward looking) volatility. One might believe that comparatively high levels of historical volatility are likely to lead to higher future volatility, but this need not be the case.[8] However, the variance of the series (or component of the series) may be systematic and predictable given its past behaviour. Thus, there will be a link between changes in *ex ante* and *ex post* volatility. Where such a link exists, the series is more likely to behave in a way where there are periods of substantial instability. It is for this reason that primary interest is in changes in *ex ante* volatility, and whether it can be predicted using historical data.

A wide range of models dealing with systematic volatility have been developed since the seminal work proposed by Engle (1982).[9] The vast majority of volatility work continues to focus on series where the future trajectory cannot be predicted from its past. Financial and stock prices behave in this way. Simply focusing on the variability of the differenced series is sufficient in this case. However, this may not be appropriate for many other series (such as agricultural prices), as there is evidence that they are cyclical, and either contain or do

6 A mean reverting series obviously implies that an unconditional mean for the series exists, and that the series has a tendency to return to this mean. This is less strong than assuming a condition called stationarity, which would assume that the other moments of the series are also constant (see Chapter 2).

7 If the series has a distribution with "fat tails", even the variance may give an inaccurate picture of the overall volatility of a series.

8 For this reason, some writers make the distinction between the realized and the implied volatility of a series.

9 For a number of papers on this topic, see Engle (1995) and the survey in Oxley et al. (1994).

not contain trends that require modelling within a flexible and unified framework. Deaton & Laroque (1992), citing earlier papers, note that many commodity prices also behave in a manner similar to stock prices (the so-called "random walk" model). However, they also present evidence that is inconsistent with this hypothesis. They note that within the random walk model, all shocks are permanent, and that this is implausible with regard to agricultural commodities (i.e. weather shocks would generally be considered transitory). In view of the mixed evidence about the behaviour of agricultural prices, I stress the importance of adopting a framework that can allow the series to have either trends or cycles or a combination of both. Importantly, there may be alterations in the variances that drive both of these components. Therefore, for the purposes of this chapter, I adopt the approach that allows for change in volatilities of both components should they occur, but does not require that both components exist.

From the point of view of this study, it is not just volatility in the forecast error that is important. Even if food producers were able to accurately forecast prices a week, month or even year in advance, they may still be unable to adapt accordingly. Aligned with this point, it may be unrealistic to believe that agricultural producers would have access to such forecasts, even if accurate forecasts could be made. Thus, I take the view that volatility can be a problem even if large-scale changes were anticipated given past information. This viewpoint underpins the definitions of volatility employed in this study.

Our definitions of volatility are also influenced by the frequencies of the available data. Because the price data for the majority of series are monthly (with a number of explanatory variables at the annual frequency), I created a measure of annual volatility using the monthly price data. "Annual volatility" should not be defined just by the difference between the price at the beginning and end of the year. Any measure should take account of the variability within the year. Therefore, to create the annual volatility measures I take yearly volatility as the log of the square root of the sum of the squared percentage changes in the monthly series. Admittedly, this is one possible measure among many. However, it is a convenient summary statistic that is distributed approximately normal, and is therefore usable within a panel regression framework. This statistic is an *ex post* measure of volatility. Year to year changes in this statistic do not imply that there is a change in the underlying variance of the shocks that are driving this series. However, any shift in the variability of the shocks that drive prices is likely to be reflected in this measure.

When focusing on the higher frequency data, this study defines volatility as a function of the variance of the random shocks that drive the series along with its serial correlation. This volatility is then decomposed into "cyclical" and "level" components. Within this approach, volatility is not just defined in terms of *ex post* changes in the series, but in terms of the underlying variance of the shocks governing its volatility. The influence of other variables on these variances can be estimated using this method. Our approach (the decomposition approach) is outlined at a general level in the following section.

Before proceeding, it is worth noting some other aspects of commodity price behaviour that are not directly explored in this chapter. Other "stylized facts" of commodity price distributions may be "skew" and "kurtosis". Skew suggests that prices can reach occasional high levels that are not symmetrically matched by corresponding lows, and that prices spend longer in the "doldrums" than at higher levels (Deaton & Laroque, 1992). Kurtosis suggests that extreme values can occur occasionally. Establishing measurements of skew and kurtosis of price distributions can be extremely difficult when the prices contain cycles and/or trends and have time-varying volatility. Some of the previous empirical work that supports the existence of skew and kurtosis has been extremely restrictive in the way the series was modelled (e.g. they assumed that the series are mean reverting). Moreover, kurtosis in unconditional price distributions can be the by-product of conditional volatility, and by conditioning the volatility of prices on the levels of stocks one may be able to account for the apparent skew in the distributions of prices. Thus, some of the other "stylized facts" may in reality be a by-product of systematic variations in volatility.

Potential factors influencing volatility

It has been argued that agricultural commodity prices are volatile because the short-run supply (and perhaps demand) elasticities are low (Dehn et al., 2005). If this is indeed a major reason for volatility, then one should see a change in the degree of volatility as production and consumption conditions evolve.

Regardless of the definition of volatility, there is ample empirical evidence that the volatility of many time series do not stay constant. For financial series, the literature is vast. For agricultural prices the literature is smaller. However, changes in volatility are evident in simple plots of the absolute changes in prices from period to period. These changes demonstrate that there is a shift in the average volatility of many agricultural prices, a fact further supported by evidence on implied volatility (FAO, 2008). This occurs against the backdrop of the general move towards market liberalization and global markets, along with dramatic changes in the energy sector with its increasing production of biofuels. I consider various factors listed below, each with a short justification. Owing to data constraints, it is not possible to include all factors in the same models over the whole period. Therefore, a subset of these factors enters each of the models depending the frequency of the data used in estimation.

Past volatility: the principles underlying Autoregressive Conditional Heteroscedasticity (ARCH) and its generalized forms (e.g. GARCH) posit that while there are periods of relatively high and low volatility, the underlying unconditional volatility remains unchanged. Evidence of ARCH and GARCH is widespread in series that are partly driven by speculative forces and may also be present in the behaviour of agricultural prices.

Trends: there may be long-run increases or decreases in the volatility of the series. Our study accounts for them by including a time trend in the variables that explain volatility. While an alternative is that volatility has a stochastic trend (i.e. a trend that cannot be described by a deterministic function of time), this possibility is not investigated here.

Stock levels: as commodity stocks fall, it is expected that price volatility will increase. If stocks are low, then the dependence on current production in order to meet short-term consumption demands is likely to rise. Any further shocks to yields could therefore have a more dramatic effect on prices. As noted earlier, the storage models of Deaton & Laroque (1992) have played an important role in theories of commodity price distributions. Their theory explicitly suggests that time-varying volatility will result from variations in stocks.

Yields: obviously, the yield for a given crop can drive the price for a given commodity either up or down. A particularly large yield (relative to expectations) may drive prices down, and a particularly low yield may drive them up. However, in this chapter the concern is not with the direction of change, but rather with impact on the absolute magnitude of the changes. If prices respond symmetrically to yields then one might expect no impact on the volatility of the series. However, if a large yield has a greater impact on prices than a low yield, then it might be expected that volatilities are positively related to yields. Conversely, if a low yield has a greater impact on prices than a high yield, then volatilities are negatively related to yields. It is difficult to say a priori which direction yields are likely to push volatility, if they influence the level of volatility at all. For example, a high yield may have dramatic downward pressure on price (downwards, increasing volatility). However, this higher yield may also lead to larger stocks in the following year (decreasing volatility in a subsequent period).

Transmission across prices: a positive transmission of price volatility is expected across commodities. International markets experience global shocks that are likely to influence global demand for agricultural prices, and these markets may also adjust to movements in policy (trade agreements, etc.) that may impact a number of commodities simultaneously. Additionally, volatility in one market may directly impact on the volatility of another where stocks are being held speculatively.

Exchange rate volatility: the prices that producers receive once they are deflated into the currency of domestic producers may have great impact on the prices at which they are prepared to sell. This also extends to holders of stocks. Volatile exchange rates increase the riskiness of returns, and thus it is expected that there may be a positive transmission of exchange-rate volatility to the volatility of agricultural prices.

Oil price volatility: perhaps one of the biggest shifts in agricultural production in the past few years, and one that is likely to continue, is the move towards biofuels. Empirical work has suggested a transmission between crude oil and sugar prices (Balcombe & Rapsomanikis, 2008). It is also likely that there is a strong link between input costs and output prices. Fertilizer prices, mechanized agriculture and freight costs are all dependent on oil prices, and will feed through into the prices of agricultural commodities. In view of the fact that the price of oil has shown unprecedented realized volatility over the past few years, there is clearly the potential for this volatility to spill over into commodity prices.

Export concentration: fewer exporting countries could expose international markets to variability in their exportable supplies. This variability might stem from weather shocks and domestic events such as policy changes. Lower Herfindahl concentration (the index I use here) would lead to higher potential volatility and vice versa.

Interest rate volatility: interest rates are an important macroeconomic factor that can have a direct effect on the price of commodities because they represent a cost to stock holding. However, they are also an important indicator of economic conditions. Interest rate volatility may therefore indicate uncertain economic conditions and subsequent demand for commodities.

Models employed

This section will outline at a general level the main elements of the models used for our analysis. As discussed in the preceding sections, I use two main methods. Each is dealt with below.

Random parameter models with time varying volatility

At the heart of this approach is the decomposition for the logged price y_t at time t :

$$y_t = Level_t + Seasonal_t + Cycle_t \tag{1}$$

The level component may either represent the mean of the series (if it is mean reverting) or may trend upwards or downwards. The cyclical component, by definition, has a mean of zero and no trend. However, the level components are driven by a set of shocks (v_t), and the cyclical components are driven by shocks (e_t). Each of these is assumed to be random, governed by a time varying variances h_{vt} and h_{et} respectively. Either of these variances may be zero for a given price, but both cannot be zero as this would imply that the series has no random variation. For the level component, a variance of zero would imply a constant mean for the series, and therefore that all shocks are transitory. If the cyclical variance was zero, this would imply that all shocks to prices were permanent.

The seasonal component is deterministic (does not depend on random shocks). I explored two different methods of modelling seasonality. The first used "seasonal dummies", whereby the series is allowed a seasonal component in each month. The second was Harvey's (Harvey, 1989, p. 41) seasonal frequency approach. Here, there are potentially 11 seasonal frequencies that can enter the model, the first of which is the "fundamental frequency". The results were largely invariant to the methods employed. However, our results presented in the empirical section use the first seasonal frequency method only. The level and cyclical components have variance, which is labelled as follows:

$$Var(\Delta Level_t): \ volatility\ in\ mean \tag{2}$$
$$Var(Cycle): \ volatility\ in\ cycle \tag{3}$$

Each of these is governed by an underlying volatility of a shock specific to each component and is shown to be:

$$Var(\Delta Level_t) = Constant_L \times h_{v,t} \tag{4}$$
$$Var(Cycle_t) = Constant_C \times h_{e,t} \tag{5}$$

Formally, for a given price series y_t (or logged series which will be used throughout this chapter) where $t = 1.....T$, it is proposed that the following autoregressive model with a random walk intercept is used:

$$\theta(L) y_t = \alpha_t + \delta' d_t + e_t \tag{6}$$

where $\theta L = \sum_{i=0}^{k} \{\theta_i L^i\}$ (a lag operator of finite length) and:

$$\alpha_t = \alpha_{t-1} + v_t \tag{7}$$

where d_t is a vector of deterministic variables[10] that are able to capture the seasonality and e_t and v_t are assumed to be independently normally distributed. The series can then be decomposed into its components:

$$Level: \ \mu_t = \theta(L)^{-1}(1-L)^{-1} v_t \tag{8}$$
$$Seasonal: \ s_t = \delta' \theta(L)^{-1} d_t \tag{9}$$
$$Cycle: \ (y_t - a_t - s_t) = \theta(L)^{-1} e_t \tag{10}$$

This therefore allows the separate analysis of the non-stationary component and the stationary component $(y_t - \mu_t)$. The overall volatility of the series is governed by the two variances $h = (h_v, h_e)$ along with the autoregressive parameters. The observed volatility is produced by the errors e_t, v_t (which are assumed to be iid normal). The inverted lag operator has the representation:

$$\theta(L)^{-1} = \sum_{i=0}^{\infty} \gamma_i L^i \tag{11}$$

[10] In this case I examined both standard seasonal dummies along with the seasonal effects variables in Harvey (1989, p. 41). In virtually variables I found little evidence of seasonality. For the results presented in this report, I continue to include the first fundamental frequency. However, in nearly all cases this was not significant. I continue to include it for consistency across models. However, removing the seasonal dummies would make little difference to the results presented here.

In the absence of stochastic volatility, the volatility in each of the series is governed by:

$$Var(\Delta\mu_t) = \left(\sum_{j=0}^{\infty}\gamma_j^2\right)h_v \quad (12)$$

$$Var(y_t - \mu_t) = \left(\sum_{j=0}^{\infty}\gamma_j^2\right)h_e \quad (13)$$

For a stationary series $h_v = 0$, in which case only $Var(y_t - \mu)$is of interest. The proposed framework is able to cope with stationary or non-stationary series, as there is no requirement that $h_v > 0$ within the model. For the purposes of this study, the distinction between two volatilities will be made as follows:

$$Var(\Delta\mu_t):\ volatility\ in\ mean \quad (14)$$

$$Var(y_t - a_t - s_t):\ volatility\ in\ cycle \quad (15)$$

The model can be extended by conditioning the variances on a set of explanatory variables in the following way:

$$\ln h_{v,t} = ln(h_v) + \lambda_v' z_t \quad (16)$$

$$\ln h_{e,t} = ln(h_e) + \lambda_e' z_t \quad (17)$$

where z_t is a vector of variables determining volatility. The two measures of volatility at a particular time then become:

$$Var(\Delta\mu_t) = \left(\sum_{j=0}^{\infty}\gamma_j^2\right)h_{v,t} \quad (18)$$

$$Var(y_{\{t\}} - \mu_t) = \left(\sum_{j=0}^{\infty}\gamma_j^2\right)h_{e,t} \quad (19)$$

(where these can be aggregated to overall measure of volatility).

Restrictions and identification

In the framework outlined above, (16) and (17) imply that the underlying volatility is governed by:

$$h_{v,t} = h_v \exp(\lambda_v' z_t) \quad (20)$$

$$h_{e,t} = h_v \exp(\lambda_e' z_t) \quad (21)$$

If λ_v or λ_e are equal to zero then the volatility in the long- or short-run component are constants. However, in the situation where h_v or h_e are zero, then the associated parameters $\lambda\ or\ \lambda_e$ become unidentified. This does not in itself preclude estimation within in a Bayesian framework. However, unless the posterior densities of h_v and h_e are both heavily concentrated away from zero, then the standard error of the lambda coefficients will be very large. If a series can be modelled in a way that the variance could be attributed either to stationary or non-stationary shocks, then the associated standard deviation in the estimates of the lambda coefficients will be large, and determining whether the shocks in the variable in question are significant will be very difficult. I avoid this problem in this study by assuming $\lambda_v = \lambda_e = \lambda$. This implies that the long- and short-run variances are proportional, but that they can vary across in t. As the values of h_v and h_e will not be close to zero simultaneously (as all the series have variation) the standard errors in the lambda coefficients will be smaller. This obviously comes at a cost. If the shocks to volatility (z_t) impact the long- and short-run components differently, then clearly there would be bias in the results. However, arguably, it is reasonable to assume that shocks in volatility are likely to co-vary across both the permanent and transitory components (should they both exist). Thus, while this assumption is essentially required for identification, it is highly plausible from an economic point of view.

Estimation

Denoting the parameters that are to be estimated as Ω, the data to be explained as Y and the explanatory data as X, the likelihood function can be viewed as the probability density of Y conditional on X andΩ. Therefore, the likelihood function can be denoted as$f(Y|\Omega,X)$. For prior distributions on Ω, $f(\Omega)$, the posterior distribution is denoted as $f(\Omega|Y,X)$ and obeys:

$$f(\Omega|Y,X) \propto f(Y|\Omega,X)\, f(\Omega) \tag{22}$$

where$\propto$denotes proportionality. For the random parameter models, the parameters of interest are:

$$\Omega_* = \left(\left\{\theta_j\right\}, \lambda_v,\ \lambda_e,\ h_v,\ h_e\right) \tag{23}$$

Normal priors are adopted for the parameters $\left\{\theta_j\right\}, \lambda_v, \lambda_e$ where the mean is zero, with a large variance so as to reflect diffuse prior knowledge.[11] For the parameters h_v and h_e inverse gamma priors can be used, as is standard in Bayesian analysis.

For any values of $(\lambda_v, \lambda_e, h_v, h_e)$ the Kalman Filter can produce optimal estimates of $\left\{\theta_j\right\}$ and standard errors for these parameters, along with the value of the likelihood function. Thus, in effect $\left\{\theta_j\right\}$ are ignored in the estimation of Ω as they are viewed as latent variables that are generated for any given values of Ω but are not required for the likelihood function. Estimations of the posterior distributions are then obtained using a random walk Metropolis-Hastings algorithm (see Koop, 2003, p. 97) to simulate the posterior distribution. The estimates of $\Omega(\overline{\Omega})$ that are then produced are the mean of the simulated parameters and the standard deviations for the simulated values can likewise be obtained. The estimates for $\left\{\theta_j\right\}$ along with the standard errors are then obtained using the values $\overline{\Omega}$ within the Kalman Filter.[12]

One can also look to the Bayesian approach to estimate panel data, in this case using Gibbs Sampling.[13] The parameters are simply:

$$\Omega = (\{\beta_{oi}\}, \{\beta_{1i}\}, \lambda_v, \lambda, \Sigma) \tag{24}$$

where Σ is the variance covariance matrix associated with the errors in equation (4).

Having made this decomposition, then one can make h_{vt} and h_{et} depend on explanatory variables. Within this chapter I consider the following explanatory variables for driving volatilities, which I have discussed earlier:

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11 Note that the priors for the autoregressive coefficients are set within the Kalman Filter.

12 Note that these point estimates are therefore conditional on the plugin estimates and strictly speaking do not reflect the mean and variance of these parameters from a Bayesian perspective.

13 Good coverage of Gibbs Sampling is provided in many textbooks. The estimation procedure of this panel can be viewed as a seemingly unrelated regression with cross equation restrictions. The details of how to estimate this model are in Koop (2003, chapter 6).

1. A measure of the past realized volatility of the series ;
2. Realized oil price volatility;
3. A measure of the average realized volatility in other agricultural prices within the data;
4. Stock levels;
5. Realized exchange rate volatility;
6. Realized interest rate volatility; and,
7. A time trend.

In each case where I use the term "realized" volatility, the measure is the square of the monthly change in the relevant series, as distinct from the *ex ante* measures h_{vt} and h_{et}respectively. Using the approach above, I then produce:

1. Measures in volatility (mean and cycle) for each of the agricultural price series through time;
2. Tests for the persistence in the changes in volatility for these series;
3. Tests for the transmission of volatility across price series; and;
4. Tests for the transmission of volatility from oil prices, stocks etc. to agricultural prices.

The panel approach

In order to complement the approach described above, I also used annual data in our analysis. A panel approach is most appropriate for needs owing to the relatively short series available (overlapping across all the variables) at the annual frequency. I employed the following approach:[14]

$$\ln V_{it} = \beta_{0i} + \beta_{1i}t + \lambda_v \ln V_{i(t-1)} + \lambda z_{it} + e_{it} \tag{25}$$

where V_{it} is a (realized) measure of volatility of the ith commodity at time t, z_{it} is a vector of factors that could explain volatility, and e_{it} is assumed to be normal with a variance that is potentially different across the commodities, serially independent, but with a covariance across i (commodities). I additionally estimate the model imposing $\beta_{1i} = \beta_1$ (a common time trend) across the models. Thus this model is one with fixed effects (intercept and trend) across the commodities.[15] Within z_{it} I consider the following:

1. Realized oil price volatility;
2. Stocks;
3. Yields;
4. Realized exchange rate volatility; and,
5. Realized export concentration (the Herfindahl index).

Where the price data are monthly, the realized annual volatility is defined herein as:

$$V_{it} = \sqrt{\frac{\sum_{j=1}^{12} \left(\Delta ln\left(p_{i.j.t}\right)\right)^2}{12}} \tag{26}$$

[14] The distribution of the volatilities was examined prior to estimation, and showed that the logged volatilities had a distribution that was reasonably consistent with normal. Therefore, estimation was conducted in logged form.

[15] The issues of trends, stochastic trends and panel cointegration are not considered in this report. The volatilities are unlikely to be I(1) processes, and certainly reject the hypothesis that they contain unit roots. Stochastic trends could exist in the stocks, yield and export concentration data, and I recognize therefore these could have an influence on the results.

where $p_{i.j.t}$ is the price of the ith commodity in the j^{th} month of the t^{th} year. As noted earlier, there are a number of other potential measures of annual volatility. However, the statistic above usefully summarizes intra-year volatility into an annual measure. Alternative transformations (such as the mean absolute deviation of price changes) are very similar when plotted against each other, and are therefore likely to provide similar results within a regression framework. The logged measure of volatility, as defined in (26), is approximately normally distributed for the annual series used in the analysis, which is attractive from an estimation point of view.

Estimation and interpretation

This study employs a Bayesian approach to estimation, which is viewed as a more robust method in the current context. The estimation of the random parameter models can be performed using the Kalman Filter (Harvey, 2007). The Kalman Filter enables the likelihood of the models to be computed, and may be embedded within Monte Carlo Markov Chain (MCMC) sampler that estimates the distributions of the parameters of interest.[16]

Interpreting parameter estimates and standard deviations

In interpreting the estimates, readers may adopt an essentially classical approach (i.e. the statistical approach with which most readers are likely to be familiar). Strictly speaking, the Bayesian method requires some subtle differences in thinking. However, there are theoretical results (see Train, 2003) establishing that using the mean of the posterior (the Bayesian estimate of a parameter) is equivalent to the “maximum likelihood” estimate (one of the most commonly used classical estimates) which shares the property of asymptotic efficiency. As the sample size increases and the posterior distribution normalizes, the Bayesian estimate is asymptotically equivalent to the maximum likelihood estimator and the variance of the posterior identical to the sampling variance of the maximum likelihood estimator (Train, 2003). Therefore, I will continue to talk in terms of “significance” of parameters, even though strictly speaking p-values are not delivered within the Bayesian methodology (and for this reason are not produced within our results section). More broadly, if the estimate is twice as large as its standard deviation, then this is roughly consistent with it being statistically significant at the 5 percent level.

Data and empirical results

The data for this study were provided by the FAO. A summary of the length and frequency of the data is provided in Table 5.1. The models discussed in the previous section will be estimated using these data. The first set of models outlined in time-varying approach will be run on the monthly series, and the panel approach will be used for the annual data. The annual price volatilities were calculated from the monthly data. There are 19 commodities listed in the tables.

Because some of the variables were recorded over a shorter period than others, the models will be run using a subset of the data. Where stocks are used at a monthly frequency,

[16] A full description of the estimation procedures is beyond the scope of this chapter; even though many of the methods are now standard within Bayesian econometrics, a full description would run many pages. Good starting references include Chib & Greenberg (1995) and Koop (2003).

they were interpolated from the quarterly data, but the models were estimated at the shorter frequency.[17]

Monthly results

I begin with the results for the monthly data run over the longest possible period for each commodity. In the first instance exchange rates were not included, as these were available only from 1973 onwards (see Table 5.1). The models using monthly data were then re-estimated including exchange rates (over the shorter period). When running the models, I imposed positivity restrictions on the coefficients of some of the explanatory variables. Without these restrictions, a minority of commodities had perverse signs on some of the coefficients, though in nearly all cases these were insignificant. The monthly results are presented in Tables 5.2. In each case the results for the model with and without exchange rates are presented for each commodity. Importantly, the time period over which the two sets of results are obtained differs for the case where exchange rates are included, as exchange rates were only available from 1973 onwards. The difference in the parameter values will therefore differ owing to this as well as to the inclusion of exchange rates. Table 5.3 presents the monthly results for the three series for which stocks data are available.

In Table 5.2 through 5.5, the error variance refers to the square root estimate of the intercept for h_e as defined previously. The Random intercept variance is the square root of the intercept estimate of h_v. The rest of the parameter estimates are the λ parameters in equations (16) and (17) where these are the coefficients of the variables listed in the first column of each table. The last four coefficients in each table include: the intercept; estimates of the autoregressive coefficients; and the seasonal coefficient (the first fundamental frequency).

The estimates within the table are the means and standard deviations of the posterior distributions of the parameters. In each case the significance of a variable is signified by the estimate in bold italics indicating that the standard deviation is less than 1.64 of the absolute mean of the posterior distribution. As noted earlier, this roughly corresponds to a variable being significant at the 5 percent level (one-tailed).

While the focus of our analysis is mainly on the determinants of series volatility, it is worth noting that the autoregressive representation of order two is sufficient to capture the serial correlation in the series. The first lag is significant for most of the commodities. In only a few cases is the second-order coefficient significant. Having said this, however, the majority of the series have negative second-order coefficients suggesting that most of the series contain cyclical behaviour. The seasonal components of the series are insignificant for nearly all commodities.[18] While the second-order coefficient and seasonal components could be removed, an exploratory analysis suggests that inclusion of these components had no substantive impact on the results. Therefore, for consistency, these explanatory variables are included for all the series.

Table 5.5 summarizes the results for the monthly data from Tables 5.2 through 5.3. Each series has two sets of results. The first is where the model is run on the longest possible period, excluding exchange rate volatility. The second is on the shorter series where exchange rate volatility is included. Therefore, the two sets of results will differ because an additional

[17] Weekly prices also exist for a few commodities only. Data were analysed, but the results were rather inconclusive. Our analysis of these data is not included in this chapter but can be made available.

[18] This finding was supported when the series were estimated with higher seasonal frequencies and seasonal dummies.

variable is included and they are run over different periods. The stocks data were available for only three of the series (wheat, maize and soybean). Therefore, I provide another table (Table 5.3) which utilizes the stocks data. Again, this is run over a shorter period than for all the previous results, as the stocks data are only available from the periods listed in Table 5.1. The rest of the column in Table 5.1 is blacked out for the other commodities for which stocks data are unavailable. A tick (√) in a given cell indicates that the variable listed in the column heading is significant in influencing the volatility of the series for one of the models in

Table 5.1: Data series summary for modelling price volatility

	Frequency series	Annual stocks	Annual yield	Annual herfindel	Monthly price	Quarterly stocks
Commodity						
Wheat	1	1962-2007	1962-2007	1961-2006	Jan 1957-Mar 2009	Jun 1977-Dec 2008
Maize	2	1962-2007	1962-2007	1961-2006	Jan 1957-Mar 2009	Jun 1975-Jun 2008
Rice, milled	3	1962-2007	1962-2007	1961-2006	Jan 1957-Mar 2009	
Oilseed, soybean	4	1962-2007	1962-2007	1961-2006	Jan 1957-Jan 2009	Dec 1990-Dec 2008
Oil, soybean	5	1962-2007		1961-2006	Jan 1957-Jan 2009	
Oil, rapeseed	6	1962-2007	1962-2007	1961-2006	Jan 1970-Jan 2009	
Oil, palm	7	1962-2007	1962-2007	1961-2006	Jan 1960-Jan 2009	
Poultry, meat, broiler	8	1962-2007		1961-2006	Feb 1980-Nov 2008	
Meat, swine	9	1962-2007		1961-2006	Feb 1980-Nov 2008	
Meat, beef and veal	10	1962-2007		1961-2006	Jan 1957-Oct 2008	
Dairy, butter	11	1962-2007		1961-2006	Jan 1957-Jan 2009	
Dairy, milk, non-fat dry	12	1962-2007		1961-2006	Jan 1990-Jan 2009	
Dairy, dry whole milk powder	13	1962-2007		1961-2006	Jan 1990-Jan 2009	
Dairy, cheese	14	1962-2007		1961-2006	Jan 1990-Jan 2009	
Cocoa	15		1962-2007	1961-2006	Jan 1957-Nov 2008	
Coffee, green	16	1962-2007	1962-2007	1961-2006	Jan 1957-Nov 2008	
Tea	17		1962-2007	1961-2006	Jan 1957-Nov 2008	
Sugar	18	1962-2007	1962-2007	1961-2006	Jan 1957-Nov 2008	
Cotton	19	1962-2007	1962-2007	1961-2006	Jan 1957-Nov 2008	
Other data						
Oil prices					Jan 1957-Mar 2009	
Exchange rates					1973-2007	
Interest rates (US 6 month treasury bill)						

Table 5.2: Random parameter models: results (without stocks)

(a) Wheat (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.02*	0.007	*0.029*	0.01
Random intercept	*0.037*	0.005	*0.035*	0.011
Lagged own volatility	*0.268*	0.046	*0.097*	0.042
Lagged agg. volatility	*0.24*	0.095	*0.351*	0.092
Oil volatility	0.054	0.037	0.196	0.076
Trend	*0.3*	0.078	*0.06*	0.064
Ex. rate volatility			0.043	0.03
Mean intercept	*3.178*	1.537	*2.982*	1.576
y(-1)	*0.514*	0.28	*0.563*	0.283
y(-2)	-0.099	0.255	-0.111	0.269
Seasonal	0.012	0.022	0.009	0.028

(b) Maize (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.035*	0.009	*0.04*	0.015
Random intercept	*0.016*	0.011	0.021	0.018
Lagged own volatility	*0.128*	0.071	0.051	0.035
Lagged agg. volatility	*0.3*	0.041	*0.155*	0.049
Oil volatility	*0.163*	0.054	*0.163*	0.057
Trend	*0.431*	0.059	*0.068*	0.041
Ex. rate volatility			*0.112*	0.062
Mean intercept	*1.932*	1.144	*1.958*	1.148
y(-1)	*0.765*	0.246	*0.728*	0.255
y(-2)	-0.145	0.242	-0.114	0.254
Seasonal	0.009	0.017	0.011	0.024

(c) Rice (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.025*	0.007	0.026	0.009
Random intercept	*0.039*	0.007	0.038	0.009
Lagged own volatility	*0.293*	0.037	0.311	0.07
Lagged agg. volatility	*0.079*	0.025	0.118	0.071
Oil volatility	*0.095*	0.037	0.301	0.071
Trend	0.064	0.043	0.053	0.056
Ex. rate volatility			0.078	0.055
Mean intercept	*3.247*	1.588	2.975	1.79
y(-1)	*0.589*	0.257	0.677	0.299
y(-2)	-0.099	0.236	-0.144	0.277
Seasonal	-0.004	0.023	0.005	0.027

(d) Soybean (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.032*	0.006	*0.035*	0.009
Random intercept	*0.03*	0.008	*0.035*	0.01
Lagged own volatility	*0.199*	0.032	*0.232*	0.073
Lagged agg. volatility	*0.369*	0.105	*0.189*	0.055
Oil volatility	0.033	0.03	0.086	0.081
Trend	0.1	0.062	*-0.236*	0.057
Ex. rate volatility			*0.201*	0.104
Mean intercept	*2.938*	1.496	*3.098*	1.602
y(-1)	*0.627*	0.271	*0.614*	0.289
y(-2)	-0.129	0.255	-0.142	0.272
Seasonal	0.006	0.021	0.005	0.027

(e) Soya Oil (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.02*	0.01	0.012	0.008
Random intercept	*0.05*	0.007	0.057	0.005
Lagged own volatility	*0.226*	0.033	0.134	0.069
Lagged agg. volatility	*0.169*	0.047	0.139	0.068
Oil volatility	*0.104*	0.042	0.19	0.108
Trend	-0.076	0.057	-0.338	0.104
Ex. rate volatility			0.358	0.113
Mean intercept	*3.936*	1.592	4.621	1.78
y(-1)	*0.521*	0.229	0.469	0.244
y(-2)	-0.119	0.208	-0.168	0.223
Seasonal	-0.001	0.025	-0.009	0.031

(f) Rape (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.018*	0.011	*0.018*	0.011
Random intercept	*0.055*	0.008	0.052	0.007
Lagged own volatility	*0.107*	0.039	*0.111*	0.052
Lagged agg. volatility	*0.263*	0.083	*0.244*	0.023
Oil volatility	*0.039*	0.023	0.098	0.074
Trend	*-0.296*	0.075	*-0.4*	0.079
Ex. rate volatility			0.16	0.12
Mean intercept	*4.428*	1.75	*4.412*	1.844
y(-1)	*0.522*	0.242	*0.528*	0.256
y(-2)	-0.183	0.226	-0.187	0.239
Seasonal	0.003	0.028	0.002	0.03

Table 5.2: Random parameter models: results (without stocks - continued)

(g) Palm (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	0.012	0.008	0.011	0.009
Random intercept	*0.069*	0.004	*0.069*	0.005
Lagged own volatility	*0.266*	0.044	*0.209*	0.068
Lagged agg. volatility	*0.207*	0.044	*0.186*	0.064
Oil volatility	*0.164*	0.06	*0.154*	0.066
Trend	*-0.212*	0.065	*-0.298*	0.069
Ex. rate volatility			*0.259*	0.084
Mean intercept	*4.616*	1.553	*4.67*	1.541
y(-1)	*0.433*	0.228	*0.437*	0.225
y(-2)	-0.172	0.2	-0.184	0.199
Seasonal	0.017	0.032	0.016	0.033

(h) Poultry (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.005*	0.003	*0.005*	0.003
Random intercept	*0.02*	0.002	*0.02*	0.002
Lagged own volatility	*0.217*	0.038	0.095	0.069
Lagged agg. volatility	*0.115*	0.034	0.037	0.025
Oil volatility	*0.031*	0.015	*0.037*	0.018
Trend	*-0.188*	0.08	-0.149	0.111
Ex. rate volatility			*0.13*	0.048
Mean intercept	2.863	1.975	2.799	1.91
y(-1)	0.475	0.421	0.484	0.409
y(-2)	-0.118	0.387	-0.113	0.387
Seasonal	-0.012	0.022	-0.013	0.023

(i) Pigmeat (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.097*	0.002	*0.098*	0.002
Random intercept	0.004	0.003	0.004	0.003
Lagged own volatility	*0.124*	0.068	*0.087*	0.029
Lagged agg. volatility	0.059	0.036	*0.062*	0.029
Oil volatility	*0.094*	0.045	*0.302*	0.046
Trend	-0.141	0.096	*-0.154*	0.047
Ex. rate volatility			*0.06*	0.036
Mean intercept	0.887	0.541	*0.895*	0.54
y(-1)	*0.868*	0.189	*0.862*	0.18
y(-2)	-0.083	0.195	-0.078	0.186
Seasonal	0.025	0.027	0.025	0.026

(j) Beef (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.019*	0.009	*0.021*	0.008
Random intercept	*0.022*	0.009	*0.029*	0.007
Lagged own volatility	*0.197*	0.049	*0.259*	0.098
Lagged agg. volatility	0.055	0.041	*0.123*	0.034
Oil volatility	0.028	0.023	0.035	0.026
Trend	*0.273*	0.107	*-0.176*	0.058
Ex. rate volatility			0.050	0.041
Mean intercept	*3.261*	1.949	*3.166*	1.656
y(-1)	0.534	0.365	*0.587*	0.322
y(-2)	-0.150	0.346	-0.184	0.300
Seasonal	-0.003	0.024	0.004	0.024

(k) Butter (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.056*	0.009	*0.064*	0.01
Random intercept	*0.059*	0.011	*0.058*	0.012
Lagged own volatility	*0.397*	0.107	*0.326*	0.108
Lagged agg. volatility	*0.126*	0.053	0.062	0.048
Oil volatility	*0.181*	0.104	*0.155*	0.062
Trend	0.032	0.068	*-0.288*	0.097
Ex. rate volatility			*0.16*	0.077
Mean intercept	*4.601*	1.39	*4.466*	1.517
y(-1)	0.057	0.218	0.056	0.236
y(-2)	0.052	0.198	0.038	0.22
Seasonal	0.01	0.029	0.003	0.035

(l) SMP (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.037*	0.015	*0.033*	0.009
Random intercept	*0.05*	0.012	*0.038*	0.009
Lagged own volatility	*0.518*	0.146	*0.529*	0.098
Lagged agg. volatility	*0.234*	0.092	*0.12*	0.07
Oil volatility	*0.377*	0.129	*0.283*	0.097
Trend	*-0.703*	0.273	*-0.477*	0.147
Ex. rate volatility			*0.216*	0.061
Mean intercept	2.232	2.532	2.256	2.676
y(-1)	0.62	0.389	0.609	0.414
y(-2)	0.077	0.36	0.085	0.386
Seasonal	-0.001	0.029	0	0.031

Table 5.2: Random parameter models (continued)

(m) WMP (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.013*	0.007	0.013	0.008
Random intercept	*0.033*	0.005	*0.035*	0.006
Lagged own volatility	*0.507*	0.1	*0.46*	0.174
Lagged agg. volatility	*0.077*	0.037	*0.156*	0.084
Oil volatility	*0.18*	0.067	*0.076*	0.032
Trend	-0.148	0.097	-0.084	0.145
Ex. rate volatility			0.337	0.213
Mean intercept	2.682	3.261	2.883	3.289
y(-1)	0.588	0.45	0.566	0.444
y(-2)	0.051	0.401	0.047	0.394
Seasonal	0.002	0.034	0.003	0.034

(n) Cheese (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.014*	0.006	*0.016*	0.007
Random intercept	*0.027*	0.005	*0.026*	0.006
Lagged own volatility	*0.351*	0.062	*0.478*	0.134
Lagged agg. volatility	*0.163*	0.052	0.068	0.045
Oil volatility	*0.18*	0.026	*0.226*	0.037
Trend	-0.044	0.058	-0.068	0.105
Ex. rate volatility			*0.125*	0.075
Mean intercept	3.171	3.661	3.103	3.746
y(-1)	0.433	0.475	0.448	0.495
y(-2)	0.165	0.434	0.159	0.449
Seasonal	0.002	0.031	0.002	0.03

(o) Cocoa (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.031*	0.013	*0.03*	0.014
Random intercept	*0.041*	0.012	*0.046*	0.014
Lagged own volatility	*0.2*	0.109	*0.206*	0.099
Lagged agg. volatility	*0.088*	0.048	0.037	0.032
Oil volatility	0.311	0.22	0.089	0.06
Trend	0.082	0.14	*-0.195*	0.08
Ex. rate volatility			0.083	0.059
Mean intercept	*4.633*	2.945	*4.499*	1.984
y(-1)	0.436	0.36	*0.527*	0.254
y(-2)	-0.044	0.346	-0.116	0.242
Seasonal	-0.002	0.04	0	0.03

(p) Coffee (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.025*	0.007	*0.033*	0.012
Random intercept	*0.051*	0.007	*0.07*	0.01
Lagged own volatility	*0.496*	0.1	*0.492*	0.077
Lagged agg. volatility	*0.181*	0.066	0.038	0.029
Oil volatility	*0.106*	0.061	*0.108*	0.056
Trend	*0.858*	0.109	0.102	0.063
Ex. rate volatility			0.076	0.057
Mean intercept	*2.025*	1.645	*2.487*	1.318
y(-1)	*0.468*	0.266	0.393	0.262
y(-2)	0.088	0.235	0.065	0.228
Seasonal	0.011	0.021	0.027	0.036

(q) Tea (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.046*	0.006	*0.037*	0.008
Random intercept	*0.044*	0.008	*0.055*	0.008
Lagged own volatility	*0.375*	0.06	*0.385*	0.1
Lagged agg. volatility	*0.085*	0.045	*0.161*	0.066
Oil volatility	0.035	0.028	0.046	0.036
Trend	*-0.098*	0.031	0.03	0.08
Ex. rate volatility			0.028	0.025
Mean intercept	*3.935*	1.292	*3.982*	1.648
y(-1)	*0.568*	0.22	*0.503*	0.267
y(-2)	-0.277	0.206	-0.222	0.243
Seasonal	0.015	0.027	0.022	0.035

(r) Sugar (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.056*	0.014	*0.047*	0.02
Random intercept	*0.06*	0.015	*0.064*	0.019
Lagged own volatility	*0.251*	0.043	*0.253*	0.08
Lagged agg. volatility	*0.099*	0.048	0.088	0.061
Oil volatility	0.102	0.067	*0.141*	0.072
Trend	*-0.234*	0.047	*-0.38*	0.081
Ex. rate volatility			*0.306*	0.111
Mean intercept	*1.147*	0.513	*1.22*	0.654
y(-1)	*0.629*	0.183	*0.584*	0.219
y(-2)	-0.093	0.172	-0.078	0.205
Seasonal	0.013	0.029	0.006	0.035

Table 5.2: Random parameter models: results (without stocks - continued)

(s) Cotton (monthly)

Parameter	Mean	Stdv	Mean	Stdv
Error variance	*0.017*	0.007	*0.039*	0.004
Random intercept	*0.023*	0.008	0.004	0.006
Lagged own volatility	*0.253*	0.12	*0.181*	0.043
Lagged agg. volatility	*0.203*	0.085	0.119	0.097
Oil volatility	*0.133*	0.048	*0.219*	0.11
Trend	*0.364*	0.134	0.004	0.047
Ex. rate volatility			*0.071*	0.037
Mean intercept	1.523	1.205	0.741	0.606
y(-1)	*0.813*	0.288	*1.156*	0.254
y(-2)	-0.198	0.272	-0.338	0.254
Seasonal	0.005	0.017	0.007	0.016

Tables 5.2 through 5.2. Two ticks in a cell indicate that the variable was significant for both models (i.e. with and without exchange rates).

Broadly speaking, the results in Table 5.5 (and Tables 5.2 through 5.2) can be summarized as follows:

1. Nearly all the commodities have significant stochastic trends (seeing as the variance in the random intercept is significant). Pork is the exception.
2. Most of the commodities have cyclical components. The exception is palm oil.
3. Past volatility is a significant predictor of current volatility for nearly all variables run over both periods (with and without exchange rate volatility). I therefore conclude that there is persistent volatility in commodity prices. That is, one would expect to see periods of relatively high volatility in agricultural commodities as well as periods of relatively low volatility.
4. There is evidence of volatility transmission across agricultural commodities for nearly all commodities (except pork). The aggregate past volatility is a predictor of volatility for most commodities. This is indicative of a situation where markets are experiencing common shocks that impact many markets rather than being isolated to one commodity or market.
5. Oil price volatility a significant predictor of volatility in agricultural commodities in the majority of series. With the growth of the biofuel sector, commodity and oil prices may become more connected, so there is reason to believe that the role of oil prices in determining volatility may be even stronger in the future.
6. As with oil prices, exchange rate volatility impacts the volatility of commodity prices for ten of the 19 series.
7. Stock levels have a significant (downward) impact on volatility for each of the three series for which data are available on stocks. This is consistent with our expectations that as stocks become lower, the markets become more volatile.
8. A number of commodity prices have significant trends. However, these trends are positive for some series and negative for others. Recent high levels of volatility in those markets should not lead us to believe that they are necessarily becoming more volatile in the long-run.

Table 5.3: Random parameter models: results (with stocks)				
	Stocks included (9 series)		Stocks not included (11 series)	
	Estimate	Stdv	Estimate	Stdv
Lagged price volatility	0.392	0.064	0.392	0.063
Export concentration	-0.07	0.104	-0.008	0.099
Yields	0.414	0.233	0.487	0.219
Exchange rate volatility	0.301	0.283	0.297	0.278
Oil price volatility	0.081	0.054	0.077	0.055
Cocoa			-0.549	0.076
Coffee	-0.363	0.102	-0.362	0.108
Tea			-0.458	0.095
Sugar	-0.148	0.068	-0.148	0.07
Cotton	-0.845	0.078	-0.845	0.08
Pooled trend	-0.083	0.042	-0.116	0.041
Trends varying across commodities				
Volatility determinants				
Lagged price volatility	0.357	0.066	0.344	0.065
Export concentration	-0.01	0.136	0.042	0.125
Yields	0.521	0.366	0.672	0.337
Exchange rate volatility	0.298	0.28	0.296	0.276
Oil price volatility	0.074	0.052	0.07	0.052
Cocoa			-0.548	0.075
Coffee	-0.361	0.101	-0.364	0.107
Tea			-0.458	0.093
Sugar	-0.148	0.068	-0.148	0.07
Cotton	-0.843	0.08	-0.844	0.084
Trends				
Wheat	-0.094	0.107	-0.122	0.105
Maize	-0.122	0.093	-0.165	0.089
Rice	-0.14	0.117	-0.195	0.111
Rapeseed	-0.231	0.123	-0.313	0.114
Palm Oil	-0.22	0.14	-0.324	0.125
Cocoa			-0.232	0.091
Coffee	0.027	0.115	0.012	0.117
Tea			-0.081	0.117

Table 5.4: Panel model results						
	Wheat		Maize		Soybeans	
Parameter	Mean	Stdv	Mean	Stdv	Mean	Stdv
Error variance	0.019	0.011	0.04	0.01	0.016	0.008
NON STATIONARY						
Lagged own volatility	0.1	0.071	0.064	0.039	0.076	0.066
Lagged aggregate volatility	0.02	0.017	0.109	0.07	0.101	0.054
Stocks	-0.11	0.031	-0.128	0.073	-0.324	0.111
Trend	0.338	0.164	0.441	0.164	0.045	0.035
Exchange rate vol	0.238	0.124	0.34	0.124	0.059	0.049
Oil price vol	0.1	0.071	0.064	0.039	0.076	0.066
AUTOREGRESSIVE						
Mean intercept	3.274	1.773	1.538	1.569	4.009	1.86
y(-1)	0.459	0.293	0.712	0.365	0.488	0.287
y(-2)	-0.059	0.278	-0.02	0.366	-0.109	0.272
Seasonal	-0.014	0.03	0.015	0.031	-0.006	0.029

Annual results

The annual results were produced using the panel approach and are presented in Table 5.4. There are four sets of results. The first two are those with and without the inclusion of stocks (this is because the stocks data cover a shorter period of time than the commodity price data). For the next two sets I restricted the trends in the panel regression so that in one they were the same across each of the commodities, while in another they were allowed to vary.

Where stocks are included, they are significant for the model in which the trend is restricted, but become insignificant when the trends in volatility are allowed to vary for each of the commodities. Notably, the estimated trends are generally negative, and the restriction of common trends across the commodities seems reasonable. Thus, the results do suggest (as with the higher frequency data) that as stocks rise, the level of volatility in prices decreases.

As with the higher frequency data, there is strong evidence of persistence in volatility. This finding is robust to the specification of the model, seeing as lagged volatility is significant in all four specifications. Yields also appear to be a significant determinant of volatility. In each of the four specifications, higher yields lead to larger volatility in the series. As argued earlier, there is no clear case for expecting yields to have a positive or negative influence on volatility in the first instance. Obviously, one would expect high yields to drive prices down and low yields to drive prices up. However, this does not imply the volatility of the series should go up or down. Our results suggest that high yields have a tendency to drive prices downwards to a greater extent than low yields drive prices up. While I do not investigate this further here, it is also possible that the response to yields is dependent on the level of stocks.

Finally, unlike the higher frequency data, there is only weak evidence that oil price volatility and exchange rate volatility have an impact on the volatility of commodity prices.

Table 5.5: Summary of results

		Error variance	Random inter-cept variance	Past own volatility	Lag aggregate volatility	Oil volatility	Trend	Ex. rate volatility	Stocks
2	Wheat	√√	√√	√√	√√		√(+)√(+)		√
3	Maize	√√	√	√	√√	√√	√(+)√(+)	√	√
5	Soybeans	√√	√√	√√	√√		√(-)	√	√
6	Soya oil	√	√√	√√	√√	√√	√(-)	√	n/a
7	Rape	√√	√	√√	√√	√	√(-)√(-)		n/a
8	Palm		√√	√√	√√	√√	√(-)√(-)	√	n/a
9	Poultry	√√	√√	√	√	√	√(-)	√	n/a
17	Coffee	√√	√√	√√	√	√√			n/a
18	Tea	√√	√√	√√	√√		√(-)		n/a
19	Sugar	√√	√√	√√	√	√	√(-)√(-)		n/a
20	Cotton	√√	√	√√	√	√√	√(+)	√	n/a

Conclusions

Several important findings emerge from our empirical study. First, there is strong evidence of persistent volatility in agricultural series. Nearly all of the series examined showed that variance was a function of past volatility, and this finding was robust to the choice of model and frequency of data. Next, there was convincing evidence that some degree of volatility transmission exists across commodities in monthly data. Where stocks and yield data were available, these also appeared to be significant determinants of the volatility of agricultural commodity prices.

There is also convincing evidence that many of the candidate variables have an impact on volatility. In monthly series, oil price volatility had a positive impact on commodity price volatility. Thus, from the evidence available, the recent coincidence of high volatility in both oil and commodity prices is symptomatic of a connection between the two. As discussed above, this link is likely to continue thanks to the impact of energy prices on the costs of production along with the alternative use of some crops for biofuel production. Therefore, one would expect the link between oil and agricultural price volatility to continue or strengthen as the biofuels sector grows. Likewise, exchange rate volatility was found to influence agricultural prices. Thus, perhaps unsurprisingly, if the global economy is experiencing high levels of volatility, it will be reflected in agricultural prices, even though no significant link between export concentration (as measured by the Herfindahl index) and oil price volatility was identified.

Finally, the evidence produced in this chapter suggests that agricultural price volatility contains trends that are independent of the variables used here to explain volatility. However, the evidence is mixed with regard to the direction of these changes. In the monthly data, these trends were positive for some commodities and negative for others. For the annual data, the evidence shows that the trends were, having accounted for oil price volatility and other factors, negative. Thus, our overall results do not predict increasing volatility in agricultural markets unless there is increasing volatility in the variables that determine that volatility. On the other hand, if factors such as oil prices continue to be volatile, agricultural prices may begin or continue to reflect that volatility.

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Chapter 6

Emerging linkages between price volatilities in energy and agricultural markets

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This chapter investigates the development of volatilities in agricultural commodity prices during and after the 2006-08 high price episode by focusing on rapeseed future prices at the Marché à Terme International de France (MATIF). We study the behaviour of daily returns of rapeseed, crude oil and related agricultural commodity prices using the method pf dynamic conditional correlation belonging to the class of multivariate General Autoregressive Conditional Heteroskedasticity Models (GARCH) models.

By looking at daily volatility developments between 1999 and 2009, particularly in the 2006-08 period, we found an increasing correlation between the returns in rapeseed and crude oil price. This correlation not only increased during the high price episode but it continued to rise afterwards. This implies that rapeseed prices react in an increasing manner to the same information as crude oil prices. Furthermore, rapeseed prices show high sensitivity to shocks and low persistency in volatilities and thus bear the risk of overreactions in volatility phases.

This increased correlation raises the prospect of even more pronounced volatilities in agricultural commodity prices during future periods of turbulence, as crude oil prices have exhibited a higher volatility level *vis-à-vis* agricultural commodity prices in the past. Because of the difficulty of distinguishing commodity price trends caused by changes in supply and demand from volatilities stemming from expectations and speculation, optimal production schemes are difficult to establish. Therefore, farmers as well as consumers will face an additional source of uncertainty owing to more prominent price changes over the long-run.

Background

Both during and after the high price episode in 2006-08, the level of agricultural product prices and their increasing volatility raised concerns among policy-makers and interest groups. The World Bank (World Bank, 2009) declared that "high volatility in food prices, combined with the impact of the financial crisis, threatens to further increase food insecurity." Episodes

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of increased volatilities imply higher uncertainty and therefore influence production and consumption decisions. Price changes should usually reflect supply or demand shifts to which markets adjust. In regimes of high and persistent volatility, however, it is difficult to distinguish between market instability and higher price levels (FAO, 2009).

Discussions about the integration of agricultural markets with energy markets took place well before the 2006-08 event, and can be exposed for several commodity markets using different econometric techniques (e.g. Balcombe & Rapsomanikis, 2008; Serra et al., 2008; De Gorter & Just, 2008). The topic of volatility in agricultural markets is, by contrast, rather new. A number of recent studies have examined price volatility linkages between agricultural and energy markets. For instance, Meyers & Meyer (2008) investigated the causes and implications of price increases between 2005 and 2008 by focusing on the impact of biofuels. While conclusions can be drawn about biofuel impact on agricultural price levels, no clear conclusions can be provided about their effects on price volatility. However, Du et al. (2009) were able to show volatility spillovers from crude oil to maize prices in the United States using a stochastic volatility model. Multivariate GARCH (MGARCH) models were used by Bekkerman & Pelletier (2009) who studied the effect of ethanol demand on maize and soybean in the US using a dynamic conditional correlation model (DCC). Tejda & Goodwin (2009) employed similar data in applying a regime switching dynamic correlation model. They found positive dynamic correlation between maize and soybeans, and provided a discussion on the impact of ethanol demand. Kananmura (2008) used a DCC model to find changing correlation between petroleum and agricultural commodity prices.

The methods commonly used to analyse volatilities in time series are GARCH- Models. They allow for rich insights into the volatility structure of time series. In addition, the multivariate versions provide information about the conditional correlation between the volatilities of different price series (for a survey on this model class see Bauwens et al., 2006). The main drawback of MGARCH models is their data and computational requirements, which demand a number of observations that are usually hard to obtain for agricultural commodities.

The current study contributes to this literature with an analysis of volatility developments in the European market. We use rapeseed prices quoted at the MATIF in Paris, which is today the most important exchange for rapeseed. Our analysis compares the volatility structure of rapeseed prices to commodity spot market prices of vegetable oil traded at Rotterdam along with Brent crude oil prices. The behaviour of volatility during and after the 2006-08 event has up to now not been analysed in detail. We aim to fill this gap and provide some insights into volatility behaviour. This should help elucidate price developments, especially volatility developments. Furthermore, we investigate the correlation in price volatility of different commodities and their evolution over time. This allows conclusions to be drawn about how closely different price pairs follow the same market information and, hence, how closely volatilities in different markets are related. The DCC model is chosen because it allows the estimation of time-varying correlations between a set of commodity returns series and thus provides insight into the temporal changes in the correlation matrix. The DCC belongs to the class of nonlinear combinations of univariate GARCH models and is particularly suitable for analysing a high series dimension, while the "Baba, Engle, Kraft and Kroner" (BEKK) model of Engle & Kroner (1995) is a multivariate extension of the univariate GARCH model suitable for up to four series only because of its exceptional computational demands (Bauwens et al., 2006; Huang & Chang, 2005).

Figure 6.1: Rapeseed price quotations at the MATIF (EUR per tonne), 2006-08 high price period (shaded area)

Source: MATIF

Market overview

Although the cultivation of rapeseed has a long tradition in Europe, the crop gained particular importance with the rise of the biofuel industry in the last decade. Biodiesel developed during this time and was transformed from being a niche product into an important driver of demand in the rapeseed oil market. Overall rapeseed area as well as production within the European Union (EU) increased strongly from 4.03 million ha (1998) to 6.49 million ha (2007), raising production from 11.65 to 21.42 million tonnes. On the global scale, the rapeseed production area increased from 25.8 million ha to 31.0 million ha over the same period, and production rose from 35.7 to 50.6 million tonnes. While rapeseed is the most important oilseed in the EU, it plays a much smaller role on the world market. Globally, soybeans (90 million ha/221 million tonnes) stand as the most important oilseed, but they have recently been outperformed by palm oil in terms of vegetable oil production (FAOstat).

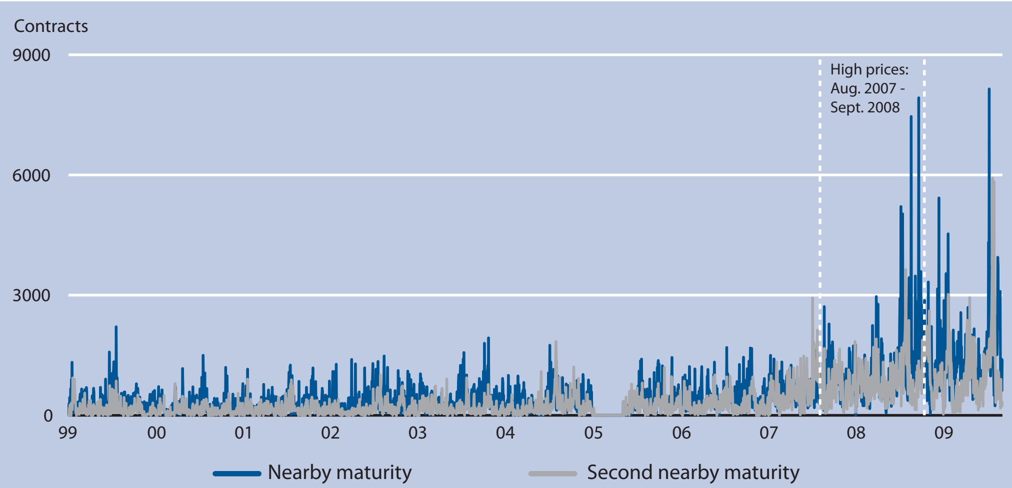
Figure 6.1 shows rapeseed price developments over the past decade. In the episode of 2006-08, rapeseed prices, as well as most other agricultural commodity prices, increased strongly and peaked in early 2008. The peak of EUR 500 per tonne reflects a doubling of prices within one year. The data shown here were obtained from the MATIF.[2]

Figure 6.2 shows the increase in traded volumes at the MATIF during the past ten years. The MATIF offers different contracts with the expiration dates of February, May, August and November for six consecutive contract months. The most important, and hence those with the highest volume, are the nearest (first) and the second-nearest front months (plotted in Figure 6.2). The series are constructed in such a way that with the expiration of one contract, the data structure is shifted towards the next date. The same principle will be used later for constructing the (synthetic) price series.

The rising importance of MATIF is illustrated by volumes reaching a level of up to 8 000 daily contracts, representing almost 1 percent of annual world rapeseed production traded

[2] For details see: www.euronext.com.

Figure 6.2: Volume of contracts traded during one day at the MATIF nearest (first) and second-nearest expiration



Source: MATIF.

on a single day. The average daily volume of trade in the nearest contract was 1 562 contracts in 2008-09 compared with 945 during 2007-08 and 536 in the period 2006-07. The average daily volume in 2008-09 was almost six times higher than in 1999-2000.

This rise in volume is not solely a phenomenon of rapeseed at the MATIF but was observed also for other agricultural commodities at commodity exchanges around the world (Robles et al., 2009). The importance of rapeseed price quotations at the MATIF grew not only for global traders but also for wholesalers and farmers. These agents do not necessarily participate at the MATIF but use these price trends for their own production and trading decisions.

The price increase in 2006-08 was accompanied by strong price fluctuations in many markets. Daily returns in rapeseed prices, calculated as $\ln(p_{t+1}/p_t)$, are shown in Figure 6.3a. Figure 6.3b shows squared returns in order to give a clearer picture of the evolution of volatility over time.[3]

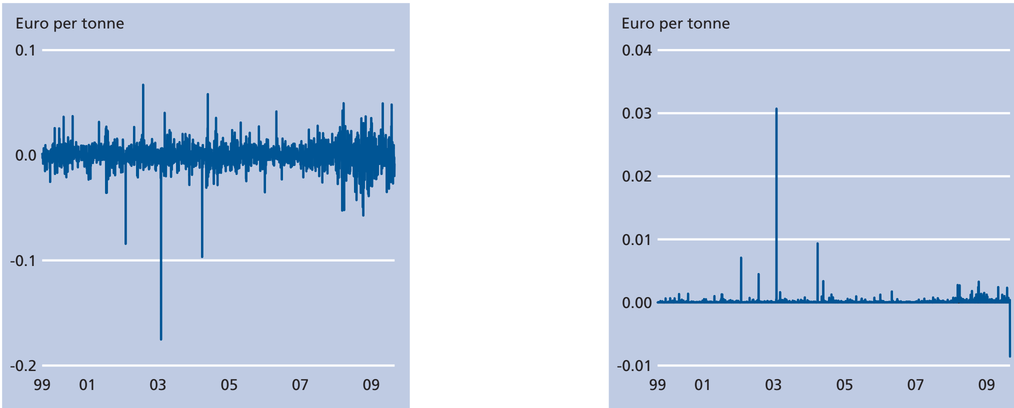
A change in volatility over time, where volatility is defined as the conditional standard deviation of the returns series, can be observed here. More important than the amplitude of price changes is the persistency in volatility. The right panel shows clearly a much higher persistency of price fluctuations in 2008 than, for example, in 2006. The price increase in 2007 was not accompanied by increased volatility but rather took place steadily. Volatility rose as late as December 2007 and became particularly high in the summer of 2008. A most interesting point is that volatility in rapeseed prices did not decrease substantially during the months after the 2006-08 event.[4]

3 We prefer using squared returns as they facilitate the distinction between phases of small and large volatility, that is, they magnify the differences between phases of clustered small and large returns.

4 A more detailed analysis of price behaviour will be provided after the results from model estimation have been obtained.

Figure 6.3: Returns and squared returns of rapeseed prices

(a) Returns (b) Squared returns



Source: MATIF.

Theoretical framework

The method used to analyse rapeseed price behaviour belongs to the class of multivariate GARCH models. MGARCH models allow for investigation of volatilities in markets as well as the correlation of volatilities between markets. These correlations can occur because the arrival of news can affect not only the price volatility on a specific market but also the volatility of different commodity prices simultaneously. The model used in this analysis is the DCC in the Engle (2002) specification that Bauwens et al. (2006) categorized as a nonlinear combination of univariate GARCH models. It can be regarded as a generalization of the Constant Conditional Correlation (CCC) model proposed by Bollerslev (1990).

The quantity of interest is a $I \times 1$ dimensional vector of returns $R_t = \{r_{i,t}\}_{i=1,\dots,I}$ where $r_{it} = ln(p_{i,t+1}/p_{i,t})$ and $p_{i,t}$ is the price of commodity i at time t. For the sake of simplicity, let us first consider the returns of only one commodity i. The conditional mean μ_t and conditional variance σ_t^2 of the series $r_t = r_{i,t}$ given the information set available in the previous period denoted by F_{t-1} are:

$$\mu_t = E(r_t|F_{t-1}) \tag{1}$$

$$\sigma_t^2 = Var(r_t|F_{t-1}) = E\left[(r_t - \mu_t)^2|F_{t-1}\right] \tag{2}$$

It is assumed that r_t follows an Autoregressive Moving Average (ARMA) process of orders p and q so that:

$$r_t = \mu_t + a_t \tag{3}$$

$$\mu_t = \phi_0 + \sum_{j=1}^{p} \phi r_{t-j} - \sum_{j=1}^{q} \theta_j a_{t-j} \tag{4}$$

The constants p and q are non-negative integers. The parameters ϕ_i and $\theta_i$are called the autoregressive (AR) and moving average (MA) parameters, respectively. a_t is the innovation of the commodity returns at time t. In the context of GARCH models, this equation is often referred to as the *mean equation* for r_t.[5] Combining (2) and (3) yields the *volatility equation* for r_t:

$$\sigma_t^2 = Var(r_t|F_{t-1}) = Var(a_t|F_{t-1}) \tag{5}$$

The analysis focuses on the evolution of the conditional standard deviation σ_t of the returns r_t, that is, the *conditional volatility* of the series.

In this univariate context, a GARCH(1,1) process can be described as:

$$a_t = \sigma_t \varepsilon_t \tag{6}$$

and

$$\sigma_t^2 = \alpha_0 + \alpha_1 a_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \tag{7}$$

where ε_t is a standardized i.i.d. random variable. Equation (7) has to satisfy the nonnegativity constraints $0 \le \alpha_1$ and $0 \le \beta_1$and the stationarity condition $\alpha_1 + \beta < 1$ which ensures that the process has finite variance (Hamilton, 1994, chap. 21).

As we are interested in the multivariate analysis of five commodities, we use the DCC model (Engle, 2002) that allows the estimation of time-varying covariances and time-varying correlations. Because this model is not so computationally demanding, it is suitable for high-dimensional analysis. In the first step, univariate GARCH models are estimated for each series and, in the second step, the dynamic correlation parameters are estimated. We follow Engle & Sheppard (2001) and assume the vector of returns follows a conditional multivariate normal distribution:

$$R_t|F_{t-1} \sim N(0,\Omega_t). \tag{8}$$

The $I \times I$ covariance matrix Ω_t of the vector of returns is allowed to be time-varying and is assumed to have the structure:

$$\Omega_t = D_t C_t D_t \tag{9}$$

where D_t is a $I \times I$ diagonal matrix, that is, $D_t = \text{diag}\left\{\sqrt{\sigma_{i,t}^2}\right\}$, $i = 1,\ldots,I$. The typical elements $\sigma_{i,t}$of this matrix can follow a number of functional forms. We adopt the usual approach in the literature and model the elements as the time-varying standard deviations of the univariate GARCH(1,1) model of each series, similarly as in (7):

$$\sigma_{i,t}^2 = \alpha_0 + \alpha_1 a_{i,t-1}^2 + \beta_1 \sigma_{i,t-1}^2 \tag{10}$$

where $(a_{1,t},\ldots,a_{I,t})' = \Omega_t^{1/2}\mathrm{E}_t$ and E_t is a $I \times 1$ random vector with properties corresponding to those of ε_t.

C_t is a $I \times I$ matrix containing the time-varying conditional correlations characterized by the following dynamic correlation structure:

$$C_t = \text{diag}\left(q_{11,t}^{-1/2},\ldots,q_{II,t}^{-1/2}\right) Q_t \,\text{diag}\left(q_{11,t}^{-1/2},\ldots,q_{II,t}^{-1/2}\right) \tag{11}$$

5 Note that this equation can be augmented by a set of explanatory variables.

where

$$Q_t = \{q_{ij,t}\} = (1-\alpha-\beta)S + \alpha(u_{t-1}u'_{t-1}) + \beta Q_{t-1} \quad (12)$$

and $i, j = 1,\ldots,I$, $u_t = D_t^{-1}a_t$ are the standardized residuals and S is the $I \times I$ unconditional variance of u_t. As above, the parameters α and β have to be non-negative and to satisfy the condition that $\alpha+\beta<1$, which ensures a mean-reverting, i.e. stationary process (Engle, 2002). The typical element of the correlation matrix C_t is thus of the form $c_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}}\sqrt{q_{jj,t}}}$ (Engle & Sheppard, 2001). The coefficient α represents here the influence of the lagged error term, and hence, the role of shocks to the market in the previous period (the ARCH parameter). The coefficient β indicates the impact of the volatility of previous periods and therefore the persistency of volatility in the market[6] (the GARCH parameter). Of particular interest is the evolution of the conditional correlation estimates $c_{ij,t}$ that can take values between plus and minus unity.

Data

The data used in this analysis are daily observations (5 obs./week) of commodity prices over the period 1999 to 2009 (2537 obs.). Rapeseed prices were obtained from the MATIF in Paris. Prices of the second-nearest contract are used because nearest contract prices tend to fluctuate heavily when the contract expires. Later contracts show a substantially lower level of activity. The other commodity prices were obtained from the Public Ledger. Soybean oil and rapeseed oil prices are collected in Rotterdam (Netherlands) as FOB (free on board) prices for crude vegetable oil. The soybean prices are import prices CIF (cost, insurance and freight) in Rotterdam for beans imported from Brazil.[7] All agricultural prices presented in Figure 6.4 are in EUR per tonne without value-added tax (VAT) or other duties. The crude oil prices are Brent prices one month forward for crude oil FOB (in EUR per barrel).

The dataset has been chosen in order to obtain comparability. Rotterdam is currently the most important trading point for agricultural commodities in Europe. Vegetable oil prices from Rotterdam are assumed to represent EU prices. Import prices for soybeans are chosen as almost no soybeans are grown within the EU. Rapeseeds as well as soybeans are crushed within the EU and very little extra-European trade of soybean oil and rapeseed oil takes place. Palm oil and sunflower oil prices are not used for this analysis because the latter have a small market share and serve a specific segment of the food-oil market. Palm oil is usually crushed in the exporting countries and imported as oil. While competition for rapeseed oil appears on the food-oil market, the competition there is much lower and no competition for rapeseed appears in the processing industry. In favour of a more parsimonious model setup, we focus on the most important commodities in relation to rapeseed.

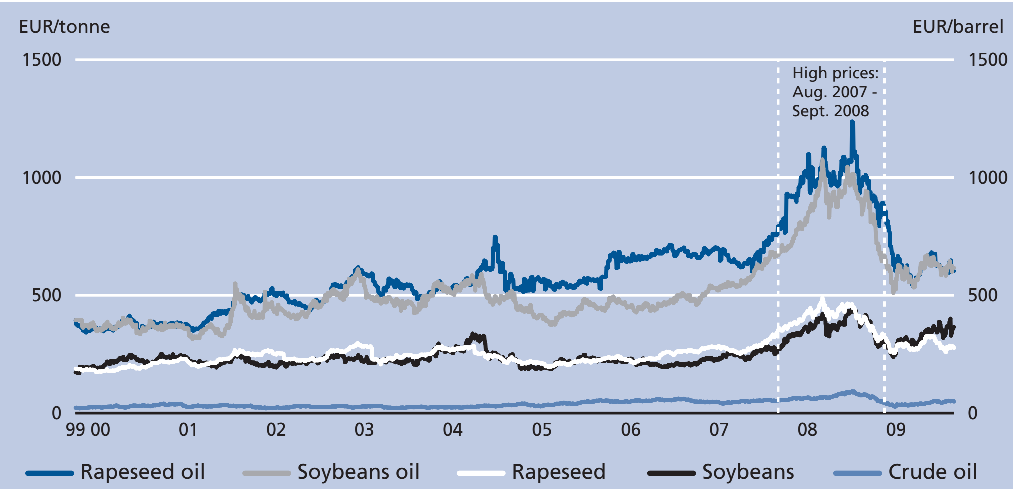
Empirical results

Prices are used in our empirical analysis as daily returns to ensure stationarity. The Augmented Dickey Fuller (ADF) test reveals non-stationarity in levels where the null

[6] This characteristic of scalar coefficients instead of matrix parameters is sometimes criticized in the literature as it implies that the estimated conditional correlations are subject to constant dynamics; see Bauwens et al (2006) for extensions.

[7] The usage of CIF and FOB prices in one model has the disadvantage that developments of e.g. transportation costs are not taken into account. However, we argue that these prices best reflect the market prices and determine the crushers and buyers choice in the EU market.

Figure 6.4: Price developments: 1999-2009, EUR per tonne (crude oil EUR per barrel)



Source: MATIF.

Table 6.1: ADF test for unit roots in levels and returns

	Levels		Returns	
	Test statistic	Lags	Test statistic	Lags
Rapeseed	-1.62	1	-47.55***	0
Soybeans	-1.98	1	-52.60***	0
Rapeseed oil	-1.64	5	-42.17***	1
Soybean oil	-1.54	8	-42.17***	1
Crude oil	-1.63	0	-21.13***	5

Note: One, two and three asterisks indicate significance at the 10, 5 and 1 percent level, respectively. Lags are chosen according to the Akaike information criterion (AIC).

hypothesis of the existence of a unit root cannot be rejected for any series (Table 6.1). However, the returns series show stationarity. From Table 6.2 it can be seen that all series show excess kurtosis in levels as well as in returns. The standard deviation of crude oil price returns is much higher than for the agricultural commodities, illustrating the substantial return fluctuations on the crude oil market.

Next, the DCC model (Engle, 2002) is estimated in two steps. The univariate part is defined as an ARMA(p,q)-GARCH(1,1) process including a constant in the mean and variance equations. The underlying ARMA(p,q) process captures serial correlation in the residuals, while the GARCH(1,1) process accounts for serial correlation in squared residuals. The second step consists of a maximum likelihood estimate based on the assumption of a student t-distribution.

The lagged parameters of the ARMA model in (4) are chosen according to the AIC and also residual behaviour, i.e. correlation in residuals and squared residuals. The results of the univariate models are displayed in Table 6.3. The rapeseed as well as the crude oil models

Table 6.2: Distribution characteristics of the returns series

	Mean	Standard deviation	Skewness	Kurtosis	ARCH test
Rapeseed	0.00015	0.0107	-2.19	37.66	0.264
Soybeans	0.00029	0.0188	-0.29	14.06	<0.001
Rapeseed oil	0.00017	0.0159	0.51	30.52	<0.001
Soybean oil	0.00018	0.0177	0.44	15.88	<0.001
Crude oil	0.00031	0.0226	-0.12	5.31	<0.001

Note: The last column contains the p-values of an ARCH test of order five.

seem over-specified, as none shows significant autoregressive or moving average behaviour in the returns series. However, both show a significant positive drift indicated by the constant in the mean equation. As the other three models show significant autoregressive and moving average behaviour, the ARMA specification is maintained for all models in order to keep the residuals free from serial correlation.

The GARCH estimates α and β appear to be significant at the 1 percent level in nearly all equations. The required conditions on the α and β parameters hold for all commodities, and hence all GARCH processes are mean reverting. However, the sums of α and β are close to unity, a phenomenon commonly observed when using high frequency data. This implies a high volatility persistency (compounded shocks to the prices) as the sum of α and β defines the decay factor of the exponentially declining autocorrelation function. High β coefficients indicate a strong impact of the own-variance on volatility development. This can be interpreted as the general volatility development in the market. Rapeseed prices show a comparatively low own-variance impact (low β) and a high sensitivity to external shocks to the market (large α). A large α combined with a low β as observed here for rapeseed prices indicates a pronounced susceptibility to external shocks in volatility phases.

Table 6.4 displays the estimated conditional correlations of the DCC model. Furthermore, α and β parameters of 0.0025 (0.0004) and 0.9973 (0.0005) are estimated, respectively. The high β coefficient indicates that the conditional correlation between the residuals is highly persistent. Although the conditional correlation is time-varying, the coefficients presented in Table 6.4 are often interpreted as their average.

At first glance, soybeans show a comparatively high correlation with rapeseed, rapeseed oil and soybean oil while all commodities show a low correlation with crude oil. Our focus will lie on rapeseed price volatilities that show, as expected, highest correlation with soybeans and rapeseed oil. The correlation between rapeseed and crude oil is not significant. This is owing to the dynamics in correlation, which will later be discussed when analysing the development over time.

Discussion

We will now discuss the empirical results in detail with a focus on rapeseed price volatilities. Figure 6.5 shows the development of the conditional variances over time. The figure had to be truncated as the variance of rapeseed price returns peaked at 0.012 in January 2003. Rapeseed prices exhibited a lower conditional variance during most of the period studied

Table 6.3: Estimation results for the univariate part of the MGARCH model

Parameter	Rapeseed	Soybeans	Rapeseed oil	Soybean oil	Crude oil
φ_0	0.0007 (0.0002)***	0.0003 (0.0002)	0.0003 (0.0003)	0.0005 (0.0002)**	0.0007 (0.0004)*
φ_1	0.161 (0.316)	0.773 (0.102)***	-0.846 (0.044)***	0.371 (0.078)***	0.110 (0.178)
θ_1	-0.014 (0.324)	-0.838 (0.089)***	0.828 (0.039)***	-0.495 (0.073)***	-0.149 (0.143)
α_0	0.000019 (0.000007)***	0.000001 (0.000004)	0.000002 (0.000001)*	0.000001 (0.000002)	0.000007 (0.000003)**
α_1	0.368 (0.147)***	0.018 (0.024)	0.022 (0.009)***	0.028 (0.011)***	0.041 (0.011)***
β_1	0.551 (0.082)***	0.978 (0.036)***	0.972 (0.010)***	0.968 (0.016)***	0.944 (0.016)***
$\alpha_1 + \beta_1$	0.918	0.996	0.994	0.997	0.986
LL	8 143	6 581	7 136	6 842	6 144

Note: One, two and three asterisks indicate significance at the 10, 5 and 1 percent level respectively. The standard deviations are given in parentheses. For the ARMA model, $p = q = 1$ in all cases. *LL* denotes the log-likelihood of the model.

Table 6.4: Estimated conditional correlations

	Rapeseed	Soybeans	Rapeseed oil	Soybean oil
Soybeans	0.386 (0.098)***			
Rapeseed oil	0.255 (0.087)***	0.400 (0.092)***		
Soybean oil	0.141 (0.070)***	0.371 (0.085)***	0.107 (0.068)***	
Crude oil	0.095 (0.065)	0.152 (0.069)***	0.097 (0.049)***	0.005 (0.080)

Note: One, two and three asterisks indicate significance at the 10, 5 and 1 percent level, respectively.

in comparison with the other series; and all series besides rapeseed show a relatively high persistency in their conditional variance.

The variance in soybean oil was higher than that of other agricultural commodities during most of the first half of the sample period, but was in line with the others thereafter. All series show a comparatively low conditional variance between mid-2005 and mid-2007. Periods of high volatility tend to cluster. Agricultural raw materials show similar patterns; except for the soybean price, variance is at a higher level. This might be owing to the fact that soybeans are imported from more unregulated countries. While the vegetable oil prices show comparable variances in levels, the frequency of increased variances appears to be more pronounced for soybean oil in the first half of the sample period. Until 2008, rapeseed prices exhibited a very low level of variance. The variance of the crude oil price also increased the most in 2008. Both were at far lower levels throughout 2007, while soybean and rapeseed oil prices had already begun displaying increased variance. During this period, agricultural prices started increasing sharply.

Conditional covariances should show a similar pattern if constant ratios to the variances are assumed. Instead of discussing the issue of covariances, we proceed directly the topic of conditional correlation estimates. These indicate the ratio between the covariances and the variances of price pairs. Most of the conditional correlations presented in Figure 6.6 show significant time-varying behaviour. While the correlation of rapeseed with rapeseed oil was decreasing, the correlation with crude oil reached a level that had not been observed before the period under investigation. This appears to indicate strong structural changes in pricing behaviour as both prices tend to increasingly react to the same market signals and their volatility develops concurrently. The model neither allows for conclusions about causal mechanisms of volatility spillovers nor is it able to capture the magnitude of influence of one market on the other. Correlations in volatility can occur from similar impacts of market signals but also from direct transmission. As the role of crude oil in the world economy is disproportionally higher than that of any agricultural commodity and has gained importance for many agricultural commodities, it can be assumed that part of this correlation is owing to reactions in rapeseed prices to volatilities in crude oil prices.

Crude oil prices exhibited higher volatility during most of the sample period compared with rapeseed. Furthermore, rapeseed prices at the MATIF are shown to be very sensitive to external shocks and tended to overreact if shocks occurred in volatility phases. The conditional correlation is higher with crude oil prices than with the corresponding spot market prices. This shows that rapeseed price volatilities do not follow the same market signals as those of the commodities on the spot markets, but rather follow the same market signals as crude oil.

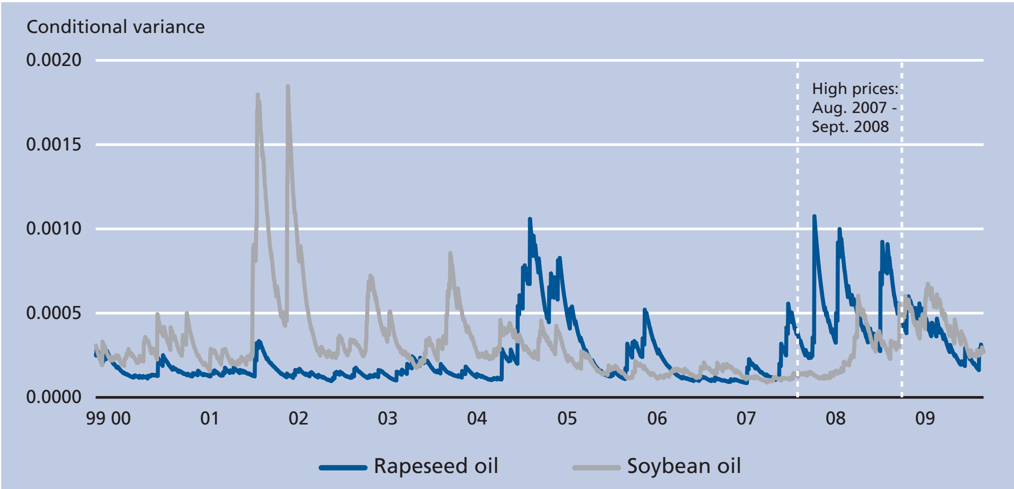
Figure 6.7 shows this development over time separately and also highlights the dynamics of the conditional correlation. The dotted line represents the average correlation where the shaded area indicates the 95 percent confidence interval. The conditional correlation estimate was not significantly different from zero for most of the period between 2001 and 2005. Furthermore, it moved around the average until the end of 2007. In 2006 and 2007 the correlation reached the level of the pre-2001 period. What stands out, however, is the strong increase in correlation after the turmoil hit its peak in midway in 2008. A conditional correlation between 0.35 and 0.40 was observed in 2008/09 that is considerably higher than during the event and significantly different from the estimated average correlation. The high persistency that was estimated for the conditional correlations can be observed here. This further indicates that such correlation will not dissipate quickly in the future.

Price fluctuations alone are not problematic as they reflect market adjustments to changes in supply and demand. However, overreaction and high volatility in the short-run might represent not only market adjustment, but speculation as well. If market signals are blurred by those effects, it becomes difficult to extract price signals from fundamentals. It therefore becomes difficult to enact production and processing decisions in an efficient manner. Furthermore, market actors have to adjust their behaviour in order to cope with increased price risk. The observation that rapeseed prices react increasingly to the same signals as crude oil prices, but react little to the same developments as commodities on spot markets, may be indicative of spillovers from investor behaviour on oil markets.

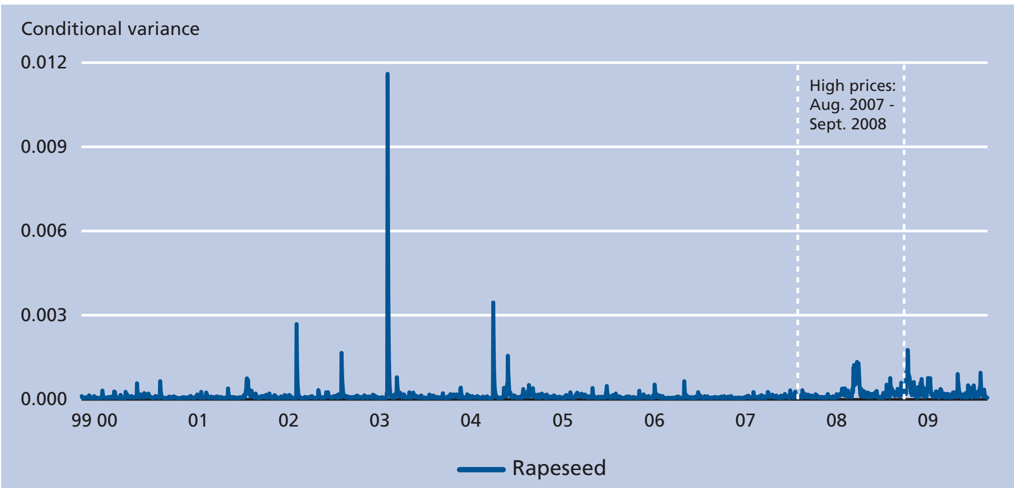
It is possible that such behaviour is mainly influenced by expectations about biodiesel production and policy. Crude oil prices determine the profitability of biofuels and any increase (or decrease) in crude oil prices improves (worsens) the competitiveness of biofuels and leads to increasing (decreasing) demand for rapeseed as the main biofuel feedstock. Hence, volatility in crude oil prices might increasingly lead to volatility in rapeseed prices as prices are adjusted towards changing expectations caused by crude oil price shifts. The

Figure 6.5: Conditional variance of different commodity price returns

(a) Rapeseed oil and soybean oil



(b) Rapeseed



reactions, hence, do not reflect actual changes in the markets but rather expectations towards changes in the medium-term. Whether, and to what extent, volatilities originate from changes in crude oil prices or from other market signals is difficult to determine. Vegetable oil prices on the spot market seem to be less affected by these market signals.

The MATIF has gained importance during the past years not only for traders but also as a centre for price discovery for farmers and wholesalers. Ambiguous price signals owing to volatility make it more difficult not only for traders to define their business strategies but also for farmers to make production decisions. Our empirical findings raise suspicion

Figure 6.5: Conditional variance of different commodity price returns (continued)

(c) Crude oil and soybeans

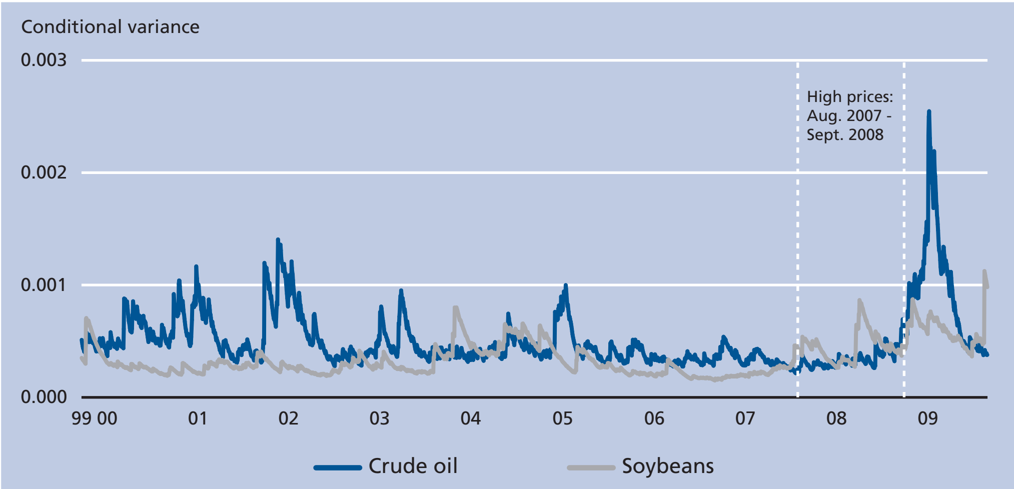
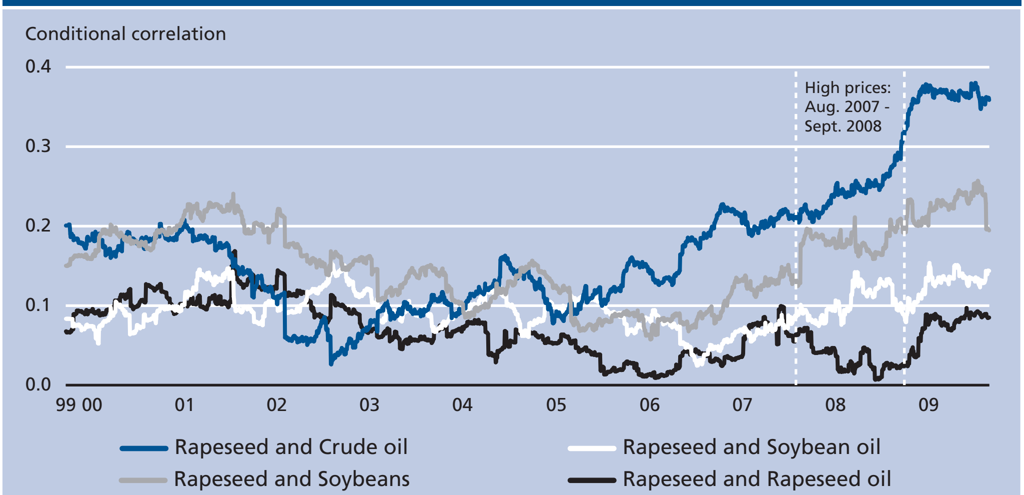


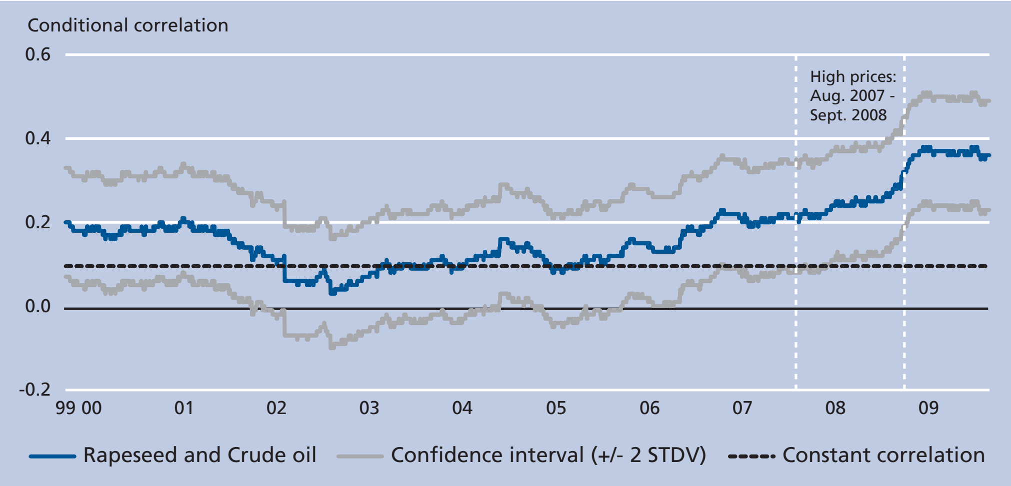
Figure 6.6: Dynamic conditional correlation of rapeseed price returns and other commodities



about how strongly returns of rapeseed prices at the MATIF reflect changes in agricultural market fundamentals. The sensitivity of rapeseed prices to shocks and the increased volatility correlation with crude oil prices points to other factors. However, it should be noted that we do not question whether rapeseed price levels are determined by crude oil prices. Market interdependencies seem to be restricted to volatility spillovers.

The variance of both rapeseed price returns as well as that of crude oil price returns increased substantially in 2008 and 2009 compared with previous years (+59 percent for

Figure 6.7: Dynamic conditional correlation of rapeseed and crude oil: straight line indicates constant correlation, shaded area +/- 2 standard deviations



crude oil, +179 percent for rapeseed). Furthermore, the variance in crude oil price returns was higher than that of many other agricultural commodities, and in the case of rapeseed more than five times higher. Based on the increase and persistence in conditional correlation with crude oil price returns, a higher volatility in rapeseed prices can be expected to continue into the future. As our analysis was conducted on price returns, and price levels are currently considerably lower than in 2008, the effects will become more apparent if prices start to increase again.

Conclusions

In our study of the volatility behaviour of MATIF rapeseed prices we found a non-stable and increasing correlation between the returns of rapeseed and crude oil prices. Furthermore, rapeseed prices are found to be relatively sensitive to market shocks. The correlations of rapeseed price returns with vegetable oil and soybean price returns on the spot market are much lower than that with crude oil. The former only moderately increased since 2006 in contrast to the correlation between rapeseed and energy markets. This indicates that rapeseed price returns react increasingly to the same market signals as crude oil price returns, if not even directly to them. Hence, if high volatilities in one market are observed, volatilities in the other will be of a similar magnitude. In view of the differences between markets in terms of traded quantity and economic importance, it seems likely that causality extends from the crude oil to the much smaller market of the agricultural feedstock. Because the MATIF has gained such importance for the rapeseed market during the past years, our findings concern not only participants at the commodity exchange but also traders and farmers who follow these price signals. Excessive volatility blurs the signals of supply and demand, making the optimization of production and processing decisions at each stage of the value chain more difficult.

We suspect that the increase in rapeseed price volatility is influenced by speculation. Additionally, its increasing correlation with crude oil indicates that rapeseed prices are not based on market fundamentals. Thus the potential for a further increase in volatilities in the future is high. Concerns about high price levels in agricultural prices and the influence of crude oil prices on them were much larger than concerns regarding their short-term fluctuation. The impact of the latter on the former should, however, not be underestimated. Our findings further imply that in the discussions of how to deal with increased volatility, the role of commodity exchanges should not be neglected. The increase in the volume of futures contracts traded at the MATIF shows its rising importance in global agricultural markets.

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Chapter 7

Grains price pass-through, 2005-09[1]

Christopher L. Gilbert[2]

The world's press and television are replete with statistics on the level of volatility of "world prices" for grains, and political discussion, particularly at the multilateral level, focuses on these prices. In most cases, the so-called world prices are prices associated with the main grains futures markets. However, these are not the prices that consumers pay in any national market and neither are they prices that farmers receive unless they are sufficiently large and well-placed to be able to deliver onto these markets. Instead, consumers pay and farmers receive local prices denominated in their own local currencies and which, to some extent, reflect local market conditions. These local prices will follow the movements in world prices to a greater or lesser extent and with a shorter or longer lag. This defines the topic of price pass-through – to what extent and how rapidly are movements in world grains prices passed through into local prices.

Pass-through is critical in the evaluation of the impact of the large movements in grains prices over the volatile five year period 2006-10, particularly in relation to the plight of consumers in Low-Income Countries (LICs). Movements in world prices are relevant to LICs only to the extent that there is pass-through. Volatility is attenuated if this pass-through is slow. Policies must reflect the extent and speed of pass-through – the focus of multilateral attention should be on those countries where pass-through is high and rapid. In those countries where pass-through is low, local prices will not have been so much affected by rises in world prices; in those countries in which it is slow, there will have been a degree of smoothing.

These issues have already been analysed in the current policy context for maize, rice, soybeans and wheat in Guatemala by de Janvry & Sadoulet (2009). Daviron (2008) looked at transmission of the high 2007-08 wheat and rice prices in six African countries.[3] In both cases, the analysis finishes in mid-2008 so the authors were unable to examine the effects of the September 2008 financial crisis on falling prices.

In this chapter, I look at the pass-through of movements in world prices of the three major grains - maize (corn), wheat and rice - in six developing countries - Benin, Kenya, Malawi, Nepal, Peru and Viet Nam (the first four of which are on the World Bank's list of LICs). The results show that pass-through varies in interesting ways both across the three grains

[1] This chapter derives from section 3 of Gilbert (2010) which was prepared under contract to the FAO. I am grateful to the following collaborators in the FAO project: Rose Edwige Fiamoh (Benin), Harriet Mugera (Kenya), Sridhar Thapa (Nepal), Hien Minh Vu (Viet Nam), Santos Maza Ysillupu (Peru) and Wouter Zant (Malawi). The views expressed are those of the author and not of those of his collaborators or the FAO.

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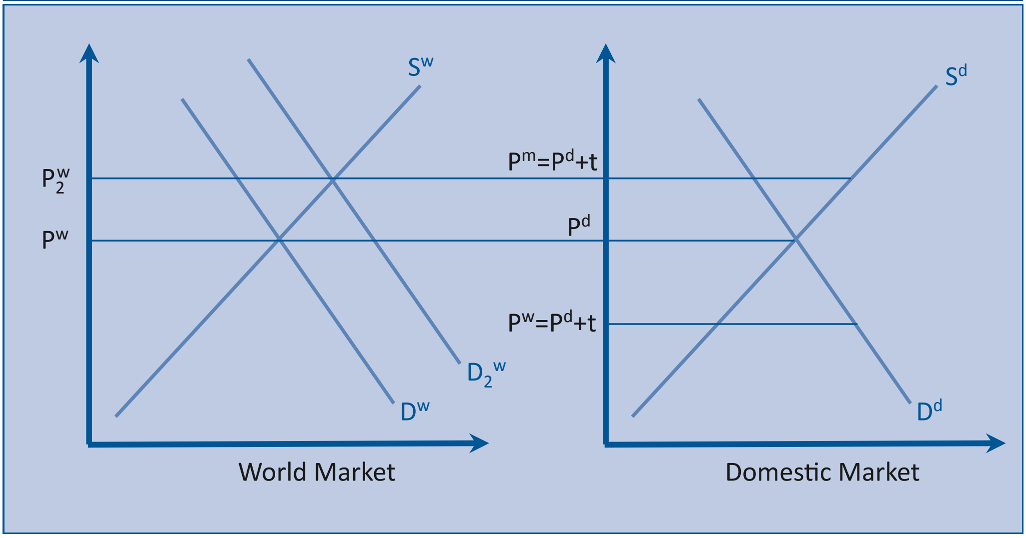
[3] Cameroon, Guinea, Madagascar, Mali, the Niger and Senegal.

Figure 7.1: Import and export parity prices: theory



and across the six countries. The following section looks at the methodologies available to analyse pass-through. These are then applied to maize, wheat and rice, respectively. The last section concludes.

Pass-through analysis

Economists often take full pass-through of world prices to local markets as an ideal as any limitation of pass-through will reduce the sensitivity of both production and consumption to price signals. Maximum pass-through will act to reduce the price response to production and consumption shocks and hence will limit price volatility.

In practice, there are three groups of factors which may limit pass-through:

1. Transport and other costs drive a wedge between prices on world markets and domestic prices. These costs can be particularly high for landlocked countries. Given a world price p^w, we can think of an export parity price $p^x = p^w - c^x$, where c^x is the cost of exporting and an import parity price $p^m = p + c^m$, where c^m is the cost of importing. So long as the domestic supply and demand curves intersect at a price p^d in the range $p^x < p^d < p^m$ domestic prices will be unaffected by world prices (Timmer et al., 1983; Baulch, 1997). This is illustrated in Figure 7.1 where the domestic price (right panel) p^d is initially equal to world price p^w (left panel). For simplicity, export and import costs are both set equal to the transport cost t resulting in a non-variation band of $2t$ around the domestic price. Shifts in the domestic supply and demand curves which keep domestic prices within this band will result in changes in domestic prices which are uncorrelated with world prices. The world price has to rise at least to $p_2^w = p^m = p^d + t$ before it affects the domestic price. High transport costs can lead to a wide band and correspondingly high levels of volatility of food prices in landlocked countries - see Dana et al. (2006) on Malawi and Zambia and Daviron (2008) on francophone Africa.
2. Governments may run successful stabilization policies serving to insulate domestic consumers from changes in world prices. Governments of food-exporting countries can do this through export

controls or variable export taxes. Many important Asian rice producing-consuming countries have adopted policies of this type - see Dawe (2007) and Timmer (2010). Such actions have the potential to reduce volatility in the protected markets at the cost of increasing volatility on the residual world market. Governments of food-importing countries can use variable import tariffs, possibly in conjunction with purchases for or sales from a food security stock - see Jayne & Tschirley (2010) and Gilbert & Tabova (2011). However, if poorly managed, such policies can aggravate volatility.

3. The prices which are regarded as measuring world prices may be unrepresentative of actual transactions prices in world trade. I suggest below that this is the case in the rice market. For other food commodities, such as cassava, there is no recognized international price. The second way is that a discrepancy of this sort can emerge is if there are substantial regional or grade differences. White maize, which is the principal staple food in most of eastern and southern Africa, is only partially substitutable by yellow maize, grown in North America and Europe. Changes in the widely quoted Chicago corn (yellow maize) price will therefore only be partially reflected in domestic African prices for white maize.

Supposing one or more world prices is relevant in a particular country, the second question is the rapidity of adjustment of local prices to the world price. This literature originated with Timmer et al. (1983) and Mundlak & Larson (1992) who regressed local on world prices. This procedure is problematic when prices trend, or are more generally non-stationary. Estimation in first differences, as in de Janvry & Sadoulet (2010), results in estimates which are robust with respect to non-stationarity but which may only measure short term responses. This may result in under-estimation of responses if adjustment is slow. On the other hand it does give precise and robust estimates of the impact responses.

Baffes & Gardner (2003) used the error correction specification to estimate pass-through. This gives rise to estimates of both impact and equilibrium responses. Error correction can be justified by the Granger Representation Theorem (Engle & Granger, 1987) if the two prices considered are cointegrated but that hypothesis is not directly tested. When three or more prices are considered, as in this chapter, the supposition that there is a single cointegrating vector is problematic.

Following Ardeni (1989), it has become standard to adopt cointegration-based methods (Johansen, 1988). This approach has four advantages over more traditional techniques:

1. The number of cointegrating vectors is determined by the data. This is important if there is more than a single contender for "world price".
2. Short run adjustment responses are distinguished from equilibrium outcomes (if present).
3. The equilibrium pass-through is not restricted to be unity. This allows for the possibility that local prices are either more or less volatile than world prices.
4. Adjustment of national and world prices is considered symmetrically allowing the possibility of reverse pass-through from national prices to the world price as well as the forward pass-through from world to national prices.

Baulch (1997) and criticized the cointegration approach as failing to allow for the wedge between export and import parity prices, illustrated above in Figure 7.1. These authors prefer to adopt a switching regime model. By contrast, Rapsomanikis & Karfakis (2008) use the Balke & Fomby (1997) threshold cointegration model to accomplish the same objective.

The analysis in this chapter relies on relatively short time series which makes these more sophisticated methods unattractive. My objective is that of modelling the local impact of recent extreme movements in world prices. In these cases, the resulting movements in the parity prices will almost certainly force an adjustment of local prices. Balke & Fomby (1997) report that standard cointegration test procedures, such as the Johansen (1988) VAR-based test, work reasonably well if the true process has the threshold structure with reversion taking place only beyond the (in this case export and import parity) thresholds. I therefore combine VAR estimates of impulse response functions with cointegration analysis to obtain estimates both of immediate impacts and, where cointegration is established, of long run responses.

Maize

Maize is the main staple food in most of Southern and Eastern Africa. It is less important in West Africa but also forms an important component of the more varied diet in Latin America. In the developed world, maize is predominantly used as a livestock feed and in North America, increasingly, as a biofuel feedstock. Different maize varieties have different colours - in Europe and the Americas, yellow maize (corn) dominates while in Southern and Eastern Africa, white maize is preferred for human consumption while yellow maize is predominantly used as a feedstock.

There are two candidates for regional or world prices in maize. The standard reference price is the Chicago Board of Trade (CBOT)[4] corn (i.e. yellow maize) futures price. However, for the African countries (Kenya and Malawi), it seems possible that the South African Futures Exchange (SAFEX) white maize futures price may be relevant. Figure 7.2 charts maize prices from January 1999 (Benin: January 2005) to December 2009 at the national level for the three African countries under consideration and Peru.[5] In addition, the figure shows the South African (SAFEX) and U.S. (Chicago) free market prices. All prices have been converted to United States Dollars per tonne at the prevailing exchange rate. The two international prices move closely together but the other four prices only track these approximately. The Malawian price series shows three "hungry season" peaks corresponding to the poor harvests in 2001 and 2005 and to the spike in world prices in 2008. The Kenyan series shows much less variation prior to the 2007-08 spike but prices appear to have been generally higher than those in Malawi.

Table 7.1 lists the nominal and real price ranges in each of the four countries considered (columns 3 and 4) and also the 2005-09 price change (columns 1 and 2). The range measures the maximum extent of the price spike while the change shows the long run impact, if any. The final two columns give the standard deviations of price changes over the period. Care must be taken in the interpretation of these real prices as, in countries in which maize forms a substantial component of the household budget, deflation makes little sense for poor households.

Over the 2005-09 period, price rises are comparable to those in world markets except in Benin. Maize prices in Benin were very high in 2005 for local reasons and hence the 2005-09 price rise appears misleadingly modest - see Figure 7.2. A 2007 base would have given very different results. Effective price stabilization has resulted in relatively stable prices in Kenya and, to the extent that this interpretation can be sustained, the maize price has declined in real terms. It is evident that that maize price variability has been acute in Malawi, whatever basis is used for making the judgement.

Statistical analysis of the nominal dollar maize price series over the five years 2005-09 confirms that the series are non-stationary, although this result in quite marginal for the SAFEX series (DF = -2.74 against a 5 percent critical value of -2.91). This near stationarity precludes the use of cointegration analysis to analyse the inter-relationship with the series using the Johansen procedure on a pair-wise basis for each of the Beninois, Kenyan, Malawian and Peruvian (logarithmic) prices and each of the log exchange prices gives within a VAR(2),

[4] CBOT is now part of the Chicago Mercantile Exchange (CME) group.

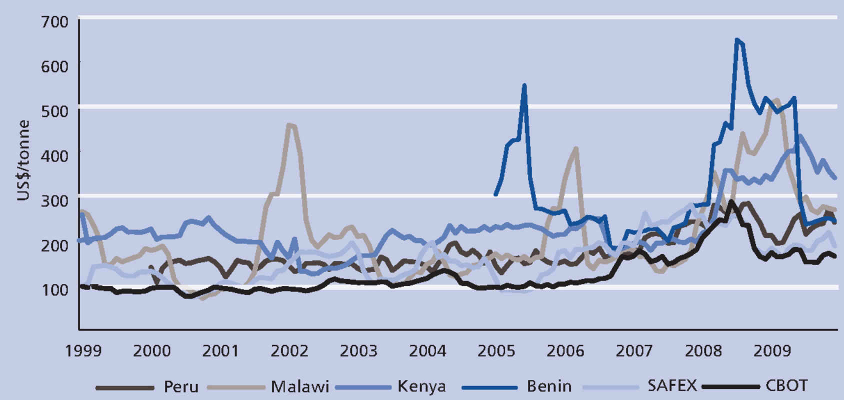
[5] National prices are medians of prices across a range of locations - see Gilbert (2010) for details.

Table 7.1: Maize price changes: 2005-09

	January 2005 - December 2009		Price range over the same period		Standard deviation of monthly changes	
	Nominal	Real	Nominal	Real	Nominal	Real
	......................%					
CBOT	71.5	50.8	204.3	140.7	26.1	24.3
SAFEX	67.2	47.1	223.9	178.3	31.3	29.3
Benin	5.0	-18.4	223.3	217.5	38.7	37.0
Kenya	62.9	-14.2	141.8	96.3	27.7	27.9
Malawi	59.2	36.3	380.6	288.2	52.3	49.4
Peru	65.3	27.7	91.1	51.5	16.5	15.1
Average price	41.7	24.6	130.4	126.6	20.0	20.3

Note: The first two columns of the table gives the percentage change in the free market (Chicago and SAFEX) maize prices and local rice prices respectively converted to United States Dollars and local prices deflated by the local commodity price index (CPI) at national prices or the Advanced Countries Export Unit Values (exchange prices and average price) over the period January 2005 – December 2009. The second two columns give the percentage range between the maximum and minimum prices over the same period and the final two columns the standard deviation of logarithmic price changes on an annual basis (i.e. the standard deviation of monthly price changes annualized by multiplying by $\sqrt{12}$). Source for exchange rates, CPI and export unit values indices: IMF, International Financial Statistics.

Figure 7.2: US Dollar maize prices: 1999-2009



fails to reject $rank(\alpha\beta') = 0$ implying each of the series is stationary. This suggests moving to longer series, I therefore analyse data from 1999-2009 for the three exchange prices and for Kenya, Malawi and Peru (price starts in 2000), for which long price series are available.[6]

6 These prices are the national prices as stated by government departments or international agencies: Kenya - Ministry of Agriculture; Malawi - World Bank; Peru - Ministry of Agriculture. Prices converted to United

Table 7.2: Statistical properties of maize price series: 1999-2009

	Stationarity	Trace cointegration tests			Implied cointegrating vectors
		rank = 0	rank ≤ 1	rank ≤ 2	
CBOT	ADF (1) - 1.36	18.7 [1.4%]	2.23 [13.6%]	-	1
SAFEX	ADF (1) - 2.16				
Kenya	DF - 1.22	37.8 [0.4%]	10.7 [23.6%]	2.51 [11.3%]	1
Malawi	ADF (2) - 2.58	34.9 [1.1%]	16.7 [3.1%]	2.46 [11.7%]	2
Peru	ADF (2) - 2.37	44.3 [< 0.1%]	15.5 [4.8%]	1.94 [16.4%]	2
Kenya Malawi Peru	-	34.7 [1.2%]	8.88 [38.4%]	0.83 [36.4%]	1

Note: Sample period is April 1999 (Peru and final row: April 2000) – December 2009. The ADF lag was selected over the range 0-3 on the basis of the Akaike Information Criterion, the 5 percent critical value is – 2.91. Cointegration is examined using the Johansen trace tests within a set of bivariate VAR(2) models. The combined first two rows consider bivariate cointegration between the Chicago and SAFEX price. The middle three rows consider trivariate cointegration between Chicago, SAFEX and each national price in turn. The reported statistics test $rank(\alpha\beta') \leq 1$ $(r = 0,1,2)$. The final row considers cointegration among the three national prices. Tail probabilities in "[.]" parentheses.

ADF tests confirm that the four (logarithmic) series are all non-stationary over this longer sample, although this result is marginal for the Malawian series - see the initial column of Table 7.2. This allows application of the Johansen (1988) procedure to analyse cointegration. I first consider the two exchange prices. A preliminary check establishes that I can consider this within a VAR(2) framework. I fail to reject the hypothesis that $rank(\alpha\beta') \leq 1$ but reject the hypothesis that $rank(\alpha\beta') = 0$ confirming that there is a single cointegrating vector - see the second and third column of Table 7.2. The estimated α coefficients are $\left(\hat{\alpha}_{Chicago}, \hat{\alpha}_{SAFEX}\right) = (-0.047, 0.087)$ with standard errors (0.023, 0.034). Both coefficients differ significantly from zero implying each market reacts to the other, but the coefficient for SAFEX is approximately double that for the Chicago market consistent with the leading role played by Chicago. I also fail to reject the hypothesis that this is a unit cointegrating vector (χ_1^2 =0.46 with p-value 50.0 percent) implying that over the long term the Chicago and SAFEX prices may be seen as moving in line with each other.

I now add the Kenyan, Malawian and Peruvian prices in turn to the VAR. Given that we already know that the Chicago and SAFEX prices are cointegrated, cointegration of the African prices requires $rank(\alpha\beta') = 2$. This result is established for Malawi and Peru but not for Kenya - see Table 7.2. Despite its proneness to weather-related shortages, in the long term, the Malawian maize market appears integrated with world markets. In line with the visual impression obtained from Figure 7.2, this is not true of Kenya.

States Dollars per kilogram at prevailing exchange rates; source: IMF, International Financial Statistics.

It is interesting to look at the Malawian and Peruvian cases in greater detail. As $rank(\alpha\beta') = 2$, we have only identified a two dimensional basis for the space in which the cointegrating vectors lie. It is therefore open to us to rotate the estimated cointegrating vectors within that space. As we have already established that the Chicago and SAFEX prices are cointegrated with unit cointegrating vector, we can reasonably impose $\beta_1' = (1, -1, 0)$ with $\alpha_{13} = 0$ (i.e. the two local prices do not react to temporary discrepancies between SAFEX and Chicago). Thereafter, the procedure differs between the two countries.

Malawi: Normalizing the second cointegrating vector, I hypothesize that this depends equally on the two exchange prices so $\beta_2' = (1/2,\ 1/2,\ -1\ )$.

As it is reasonable to suppose that the Chicago price is unaffected by the maize situation in Malawi, we can impose $\alpha_{21} = 0$ in the Malawian case. More tendentiously, we can impose the same condition on the SAFEX price, i.e. $\alpha_{22} = 0$. This implies a total of 5 restrictions on the $\alpha\beta'$ matrix. The likelihood ratio fails to reject these restrictions ($\chi_5^2 = 2.39$ with p-value 79.2 percent) implying an acceptable identification. The estimated α matrix is:

$$\begin{pmatrix} \hat{\alpha}'_{Chicago} \\ \hat{\alpha}'_{SAFEX} \\ \hat{\alpha}'_{Malawi} \end{pmatrix} = \begin{pmatrix} -0.056 & 0 \\ 0.087 & 0 \\ 0 & 0.014 \end{pmatrix} \quad \text{with standard errors:} \begin{pmatrix} 0.026 & - \\ 0.038 & - \\ - & 0.028 \end{pmatrix}$$

Conditional on the acceptability of these restrictions, the estimates show that we can reject both the null hypotheses $\alpha_{Chicago} = 0$ and $\alpha_{SAFEX} = 0$ implying that the markets are interdependent. However, in line with the earlier result, SAFEX reacts more than Chicago to deviations from parity.

Peru: It seems unlikely that the South African white maize price can influence the yellow maize price in Peru so I set $\beta_2 = (1, 0, -1)$. As in the case of Malawi, we can use a "small country" restriction to suppose that Peruvian prices have no influence on the exchange prices allowing us to set $\alpha_{21} = \alpha_{22} = 0$. As again in Malawi, the likelihood ratio fails to reject these restrictions ($\chi_4^2 = 1.02$ with p-value 90.7 percent) implying an acceptable identification. The estimated α matrix is now

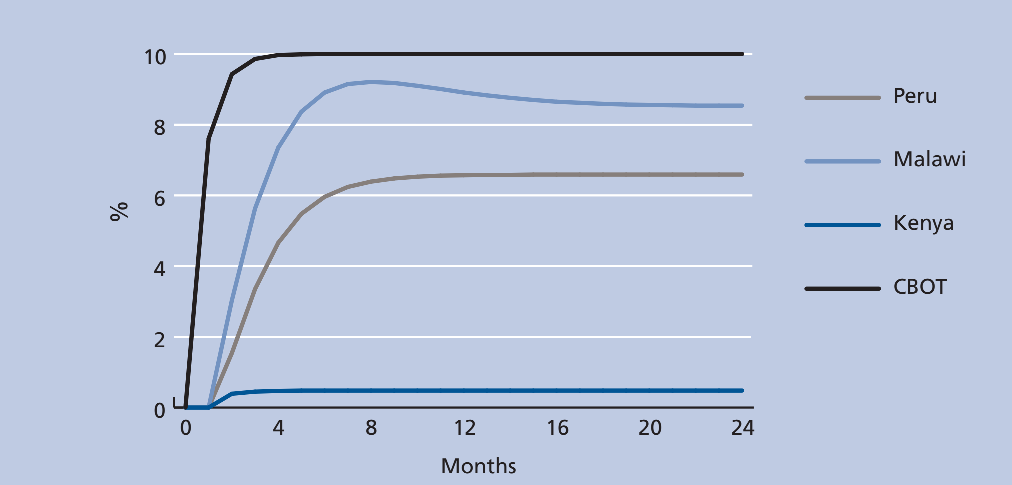
$$\begin{pmatrix} \hat{\alpha}'_{Chicago} \\ \hat{\alpha}'_{SAFEX} \\ \hat{\alpha}'_{Peru} \end{pmatrix} = \begin{pmatrix} -0.062 & 0 \\ 0.074 & 0 \\ 0 & 0.409 \end{pmatrix} \quad \text{with standard errors:} \begin{pmatrix} 0.026 & - \\ 0.039 & - \\ - & 0.070 \end{pmatrix}$$

It is reassuring to see that the estimated α coefficients for the two exchange prices are very similar to those in the Malawian model.

The final row of Table 7.2 looks at cointegration among the three national prices ignoring the exchange prices. The test establishes a unit cointegrating rank implying two common trends consistently with cointegration of the Malawian and Peruvian prices with the exchange prices, which are themselves cointegrated, but lack of cointegration of the Kenyan prices with the exchange prices.

Impulse response functions are computed using a cointegrated VAR(1), i.e. a CVAR(1), relating the change in the maize prices in Kenya, Malawi and Peru to changes in the Chicago maize price (Figure 7.3) . (To maintain simplicity, only a single exchange price was considered in the calculation of impulse responses). The VAR specification imposes block exogeneity such that the changes in the three national prices only enter their respective national equations. The Malawian and Peruvian price equations include an unrestricted error correction term defined in terms of the two month lags of the Chicago price and the national price. Consistently with

Figure 7.3: Estimated impulse response functions: maize



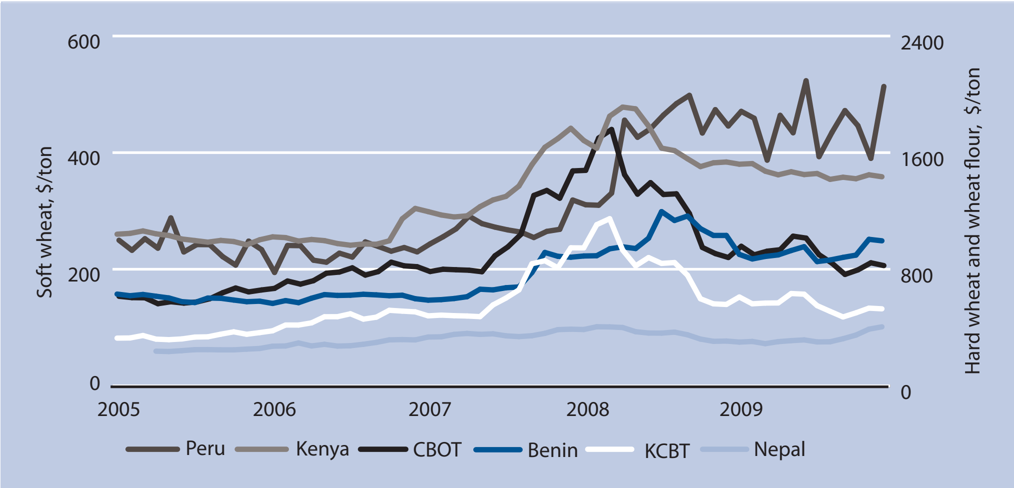
the results reported in Table 7.2, no error correction term is included in the Kenyan equation. Estimation is by Full Information maximum Likelihood (FIML). Results are reported in Tables 7.7 to 7.9.

The impulse response consists of a 7.61 percent shock to the Chicago price which, once the first order autoregressive term is taken into account, generates a long run 10 percent rise in that price. Figure 7.4 charts the resulting rises in the three national prices. The long run effects are similar in Malawi or Peru where local prices rise by 7-9 percent with an approximate six month lag. Malawi is seen as having both a greater and a faster pass-through than Peru. However, consistently with the cointegration analysis, there is almost no impact on Kenyan maize prices where estimated pass-through is effectively zero.

Both the Kenyan and Malawian governments actively intervene in their respective maize markets. Jayne et al. (2006) date that between 1995 and 2004, the Kenyan National Cereals and Produce Board (NCPB) purchased between 15 percent and 57 percent of the domestically marketed maize output while the Malawian Agricultural Development and Marketing Corporation (ADMARC) purchased between 12 percent and 70 percent of output over the same period. The boards have the ability to set maximum purchase prices for the private sector. They also control imports and exports through licensing and duties. There is considerable uncertainty as to the likely availability of import licenses and import duties are varied according to the economic and political circumstances (Jayne & Tschirley, 2010). In principal, therefore, it would not be surprising to find very limited pass-through in either country.

Despite this substantial government presence, the results reported above and the statistics in Table 7.1 indicate that while Kenya has been relatively successful in stabilizing its domestic maize prices, Malawi has been much less so. Jayne & Tschirley (2010) provide a detailed discussion of both Kenyan and Malawian policy in 2007-08. An important factor working against cointegration in Kenya was the January 2009 decision to abolish the 50 percent tariff on maize inputs. Despite this, Kenyan prices remained well above import parity for much of 2009 because of transport shortages from the port of Mombasa. Kenya therefore

Figure 7.4: US Dollar wheat prices: 1999-2010



remained autarchic in practical terms throughout the period under study. This contrasts with the situation in Malawi. There, an over-optimistic official forecast of a 2007/08 maize surplus led the government to authorize exports, probably destined for neighbouring Zimbabwe. The surplus failed to materialize but government, unwilling to lose its reputation as having moved Malawi from being a food deficit to a food surplus country remained unwilling to license imports resulting in prices rising well above import parity. Kenya therefore stands out as having effectively insulated local maize prices against movements in world markets albeit at the cost of a higher average price.

Wheat

Wheat is the major grain entering human consumption in Europe and North America. It is also consumed throughout the developing world where it nevertheless generally forms a smaller component of diets. In tropical countries, wheat is almost entirely an imported crop, either directly or in the form of wheat flour.

Wheat is traded on a number of major futures markets. The two major U.S. markets are the Chicago (CBOT) market for soft wheat, mainly used in confectionary, and the Kansas City Board of Trade (KCBT) market for hard wheat, used for bread. The Paris (Marché à Terme International de France - MATIF) market for unmilled wheat has become increasingly important as a pricing basis for Russian and Ukrainian deliveries. I focus on the two principal U.S. prices. The CBOT[7] price for soft wheat, which is predominantly used for confectionary, is the most widely used reference price. The reference price for hard (durum) red winter wheat, used in making bread, is the KCBT price.

Figure 7.4 charts wheat prices from January 2005 to December 2009 at the national level

7 Originally Chicago Board of Trade, now Chicago Mercantile Exchange. I also investigated using the MATIF price, which has become more important as a reference over recent years, but this did not add to the explanation.

Table 7.3: Wheat price changes: 2005-09

	January 2005 - December 2009		Price range over the same period		Standard deviation of monthly changes	
	Nominal	Real	Nominal	Real	Nominal	Real
	........................%........................					
CBOT	34.3	16.7	212.1	155.2	26.2	25.4
KCBT	60.2	39.3	256.7	188.1	28.5	27.5
Benin (wheat flour)	57.5	22.3	110.2	62.9	18.2	16.7
Kenya (wheat flour)	37.7	-27.5	97.6	47.2	13.9	12.1
Nepal	68.4	15.9	70.2	39.6	13.8	12.0
Peru	105.6	58.8	169.1	112.6	39.8	38.6
Average price	54.6	33.0	82.3	55.1	25.9	24.1

Note: The first two columns of the table gives the percentage change in the free market wheat prices and local wheat or wheat flour prices respectively converted to United States Dollars and local prices deflated by the local CPI (national prices) or the Advanced Countries Export Unit Values (exchange prices and average price) over the period January 2005 – December 2009. The second two columns give the percentage range between the maximum and minimum prices over the same period and the final two columns the standard deviation of logarithmic price changes on an annual basis. Source for exchange rates, CPI and export unit value indices: IMF, International Financial Statistics.

for Nepal and Peru (left axis) and the wheat flour prices for Benin and Kenya (right axis).[8] In addition, the figure shows the CBOT price for soft wheat (left axis) and the KCBT price for hard wheat (right axis). All prices have been converted to United States Dollars per tonne at the prevailing exchange rate. The prices move closely together over 2006-07 but diverge in 2008-09 when the Peruvian wheat price and the Kenyan and Nepalese flour prices fail to follow the fall in world prices.

Table 7.3, which has the same format as Table 7.1 for maize, lists the nominal and real price ranges in each of the four countries considered (columns 3 and 4) and also the 2005-09 price change (columns 1 and 2). The range measures the maximum extent of the price spike while the change shows the long run impact, if any. The final two columns give the standard deviations of price changes over the period.

The KCBT hard wheat price has tended to rise relative to the CBOT soft wheat price over the period concerned. Wheat and wheat flour prices in Benin, Kenya and Nepal were less variable than the exchange prices although, except in Kenya, the overall rise in prices was comparable. Peruvian wheat prices were the most variable on a month-to-month basis even though there was no pronounced spike in prices in 2008.

Statistical analysis of the nominal dollar maize price series over the five years 2005-09 confirms that the series are non-stationary - see Table 7.4. I therefore turn to cointegration analysis following the sequential procedure previously adopted for maize. Accordingly, I first consider the two exchange prices. A preliminary check establishes that I can consider

[8] The Kenyan price is the official national price while the remaining national prices are medians of prices across a range of locations - see Gilbert (2010) for details.

Table 7.4: Statistical properties of wheat price series: 2005-09

	Stationarity	Trace cointegration tests			Implied cointegrating vectors
		rank = 0	rank ≤ 1	rank ≤ 2	
CBOT	ADF (1) - 1.52	12.2 [15.1%]	3.45 [6.3%]	-	0
KCBT	ADF (1) - 1.61				
Benin	DF - 0.67	21.4 [31.4%]	7.82 [49.2%]	1.73 [18.9%]	0
Kenya	ADF (1) - 1.25	20.5 [40.0%]	8.68 [40.3%]	2.60 [10.7%]	0
Nepal	ADF (3) - 1.38	18.9 [50.9%]	6.70 [61.8%]	0.97 [32.5%]	0
Peru	ADF (2) - 0.28	26.6 [11.5%]	11.2 [20.4%]	3.33 [6.8%]	0
Benin Kenya Peru	-	31.1 [3.5%]	13.8 [8.7%]	1.95 [16.2%]	1 or 2

Note: ADF sample period is January 2005 (Nepal: August 2005) – December 2009. The ADF lag was selected over the range 0-3 on the basis of the Akaike Information Criterion. 5 percent critical value is – 2.92. Cointegration sample January 2005 (Benin and final row: March 2005; Nepal: June 2005) – December 2009. Cointegration is examined using the Johansen trace tests within a set of bivariate VAR(2) models. The combined first two rows consider bivariate cointegration between the Chicago and Kansas City prices. The next four rows consider trivariate cointegration between Chicago, Kansas City and each national price in turn. The final row considers cointegration among the three listed national prices. The reported statistics test $rank(\alpha\beta') \le 1$ $(r = 0,1,2)$. The final row considers cointegration among the three national prices. Tail probabilities in "[.]" parentheses.

this within a VAR(2) framework. I fail to reject both the hypothesis that $rank(\alpha\beta') \le 1$ and the hypothesis that $rank(\alpha\beta') = 0$ indicating lack of cointegration - see the second and third column of Table 7.4. Extension of the sample back to March 1999 gives the same result.[9] A test fails to reject block exogeneity of the VAR - $\chi^2(4) = 5.55$ with tail probability 23.5 percent implying the comovement in the hard and soft wheat prices is entirely owing to common shocks. This is consistent with the view that hard and soft wheat are different grains and not different grades of the same grain. Adding each of the four national prices in turn fails to produce any departure from non-stationarity indicating that none of the national prices is cointegrated with either of the world prices.

Despite this negative result, it is nevertheless possible to establish cointegration between three of the four national wheat prices (those for Benin, Kenya and Peru) - see Table 7.4, final row.[10] The Johansen trace test fails to reject $rank(\alpha\beta') \le 2$ but does reject $rank(\alpha\beta') = 0$ implying at least one cointegrating vector. The intermediate hypothesis $rank(\alpha\beta') \le 1$ is rejected at the

9 Test statistics for *rank* 0 and *rank* ≤ 1 respectively 7.39 and 2.30 with *p*-values 53.9 percent and 13.0 percent respectively.

10 Nepal was excluded because it limits the sample size and because it does not appear to enter any of the cointegrating relationships.

10 percent but not the 5 percent level. Analysis of the estimated α and β matrices for the case of $rank(\alpha\beta') = 2$ allows imposition of the restrictions

$$\beta = \begin{pmatrix} -1 & 0 \\ 1 & 0 \\ 0 & -1 \end{pmatrix},$$

implying a unit cointegrating vector linking each pair of prices, and

$$\alpha = \begin{pmatrix} 0.258 & 0 \\ 0 & 0 \\ 0 & 0.206 \end{pmatrix},$$

with estimated standard errors

$$\alpha = \begin{pmatrix} 0.065 & 0 \\ 0 & 0 \\ 0 & 0.080 \end{pmatrix}.$$

The zero restriction on the second row of the α matrix implies that the Beninois and Peruvian prices react to discrepancies relative to the Kenyan price but not vice versa. The likelihood ratio test on the combined set of restrictions is $\chi^2(6) = 8.21$ with tail probability 22.3 percent.

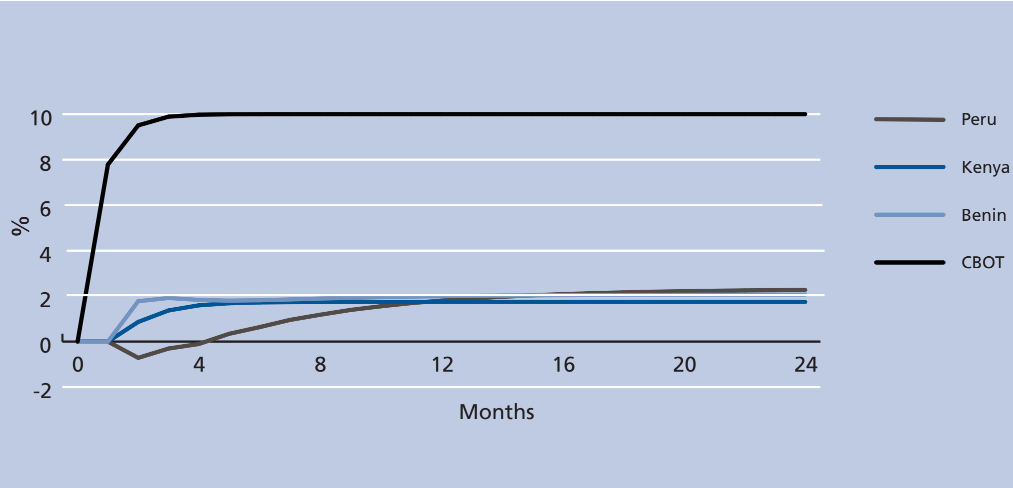
This surprising result suggests that, relative to the group of countries we have considered here, the Kenyan wheat flour price is playing the role that we would have expected the world price to play. Kenya is not an important player in the world wheat market. The result should therefore be interpreted as indicating that movements in the Kenyan wheat flour price were representative of the prices other countries were paying and not indicative of a causal relationship.

As in the case of maize, we compute impulse response functions using a cointegrated CVAR(1), relating the change in the wheat or what flour prices in Benin, Kenya and Peru to changes in the Chicago wheat price. However, differently from the maize case and reflecting the lack of cointegration of the national prices with the Chicago price and the apparent representativeness of the Kenyan price, the VAR specification imposes block exogeneity such that the changes in the Beninois and Peruvian prices only enter their respective national equations while changes in the Kenyan price do affect the other two prices. Similarly, the Beninois and Peruvian price equations included as an unrestricted error correction term the two month lag of both the Kenyan price and the respective national price. No error correction term is included in the Kenyan equation. Estimation was by Full Information maximum Likelihood (FIML). Results are reported in Table 7.8.

The impulse response consists of a 7.78 percent shock to the Chicago price which, once the first order autoregressive term is taken into account, generates a long run 10 percent rise in that price.[11] Figure 7.5 charts the resulting rises in the three national prices. The long run effects are similar in the three countries with a pass through of 2 percent, i.e. 20 percent of the shock to the Chicago price. Adjustment is seen as much slower in Peru than either Malawi or Peru.

11 Slightly larger than in the case of maize reflecting differences in the two samples.

Figure 7.5: Estimated impulse response functions: wheat



These results contrast strongly with those obtained earlier for maize. The econometric results indicate only a low level of pass-through from world to local prices with no clear-cut long-run relationships between the two groups. Nevertheless, the prices in Benin, Kenya and Peru, widely separated countries with no important trade links, appear to move together. Furthermore, local wheat and wheat flour prices did rise in 2008 indicating pass-through of the price rises. But, as world prices fell back in 2009, the local prices failed to follow through. The countries we have examined appear to have suffered from the 2007-08 price rises but failed to benefit from the price falls.

There are several possible explanations for the absence of comovement between the national wheat prices and the corresponding exchange prices. One reaction is that the five year period considered is too short to look at cointegration which, if it exists, is a long run relationship. Nevertheless, if one is interested in pass-through, this is the relevant horizon. This analysis has pointed to the failure of national wheat and wheat flour prices to decline from mid-2008 to the same extent as exchange prices. Possible explanations might relate to forward pricing or long term contracting arrangements which locked importing countries into high prices, or perhaps the exercise of market power either by importers or parastatal grains agencies.

Rice

Rice is the main staple grain throughout most of Asia. It also forms an important component of the diet in the remainder of the world, particularly in West Africa. The standard reference price is the Bangkok spot price reflecting the fact that Thailand is the major world rice exporter. This spot price is related to the white rice futures contract on the Agricultural Futures Exchange of Thailand (AFET) although trading in this contract remains very thin. Rough (i.e. unmilled) rice is also traded in Chicago on CBOT but volumes are low relative to those on other Chicago grains markets and the contract is regarded as being primarily of domestic interest.

Figure 7.6: US Dollar rice prices: 2005-09

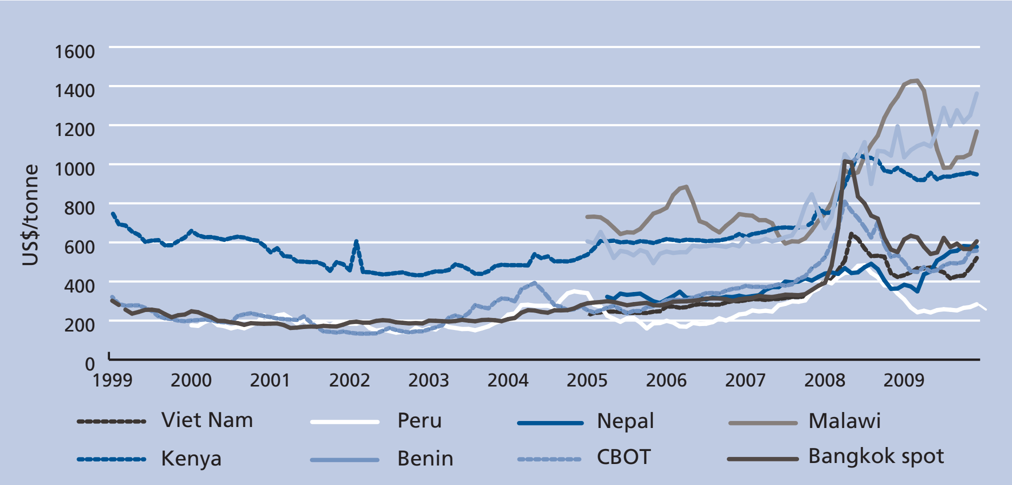


Figure 7.6 charts local rice prices from January 2005 to September 2010 for the six countries under consideration, and in addition includes the Bangkok and CBOT prices.[12] All prices have been converted to United States Dollars per tonne at the prevailing exchange rate. The figure shows the prices falling into two groups: three low price countries (Nepal, Peru and Viet Nam) and the three high price African countries (Benin, Kenya and Malawi). The world free market price is typically closer to prices in the non-African group but rose to African levels in 2008. It is apparent from Figure 7.6 that the Bangkok price has been much more variable than any of the national prices.

Table 7.5 shows considerable variation across countries in the evolution of deflated rice prices over 2005-09. Although the change in the Bangkok price over the five year period is comparable to that in the six countries considered, the range between the maximum and minimum prices was approximately double for the former. As was the case of maize, care must be taken in the interpretation of these real prices in countries in which rice forms a substantial component of the household budget. With this qualification, the statistics show a decline in real rice prices in Peru over the five years 2005-09 and almost no change in Kenya, while real prices have risen by 20 percent-40 percent in Malawi and Nepal, and 60 percent-75 percent on Benin and Viet Nam. Prices in each country clearly reflect specific local conditions. This motivates consideration of the average world price, averaging over the six countries considered. The final row of Table 7.5 confirms this greater variability of the free market prices relative to the average price.

Table 7.6 lists the statistical properties of the nine nominal United States Dollar rice price series considered in Table 7.5. ADF tests show that all nine logarithmic series are

[12] The Chicago price relates to rough rice whereas the remaining prices are for white rice. I have used a conversion factor of 1.67 to convert the Chicago price onto a milled basis. Rice prices for Malawi, Nepal, Peru and Viet Nam are calculated as the medians of prices across localities - see Gilbert (2010). Local prices are not available for Benin and Kenya: Benin - “regular rice”, Cotonou, urban market, F.CFA/kg, Ministère du commerce, Direction de la Promotion du Commerce Intérieur; Kenya - Average wholesale price, rice grade 2, loose, Ksh/kg, Kenyan National Bureau of Statistics. Because of different specifications, prices are not perfectly comparable across countries.

Table 7.5: Rice price changes: 2005-09

	January 2005 - December 2009		Price range over the same period		Standard deviation of monthly changes	
	Nominal	Real	Nominal	Real	Nominal	Real
	............................%............................					
Free market (Bangkok)	110.1	82.7	266.1	181.8	30.8	29.0
Free market (Chicago)	119.9	91.2	240.9	165.4	21.9	19.3
Benin	124.9	74.6	175.7	99.9	27.0	25.1
Kenya	76.5	-7.1	95.2	33.3	10.7	9.6
Malawi	59.9	36.8	140.3	91.6	19.3	16.9
Nepal	79.3	23.5	100.6	42.7	19.8	15.8
Peru	-16.7	-35.6	202.4	135.1	27.4	26.2
Vietnam	129.7	58.1	184.1	92.6	19.4	18.2
Average price	89.0	62.5	89.2	71.5	10.1	9.3

Note: The first two columns of the table gives the percentage change in the free market rice prices and local rice prices respectively converted to United States Dollars and local prices deflated by the local CPI over the period January 2005 (Nepal and Average: April 2005) – December 2009. The second two columns give the percentage range between the maximum and minimum prices over the same period and the final two columns the standard deviation of logarithmic price changes (at an annual rate). The deflator for the free market price and the average price is Advanced Countries Export Unit Values. Source for exchange rates, CPI and export unit value indices: IMF, International Financial Statistics.

non-stationary. Table 7.6 also reports Johansen cointegration tests. In the first two rows, I ask whether the Bangkok and Chicago free market prices are cointegrated. The results are inconclusive but consistent with a lack of cointegration - the Johansen test marginally fails rejects $rank(\alpha\beta') \leq 1$ which would imply both prices are stationary, contradicting the clear results from the ADF tests. Ignoring that result, the second test also fails to reject $rank(\alpha\beta') = 0$. I conclude that the rank is zero and there is no cointegration. The ADF test on the logarithmic difference of the two prices gives a statistic of ADF(1) = -2.26.

To check on this result, the test was rerun using the longer sample March 1999 - December 2010. ADF tests again confirm non-stationarity (Bangkok, ADF(2) = -2.58; Chicago, ADF(1) = - 0.76). The Johansen test now gives a clear rank zero result. The tests fail to reject both $rank(\alpha\beta') \leq 1$ (trace statistic 0.50 with p-value 48.1 percent) and $rank(\alpha\beta') = 0$ (trace statistic 9.74 with p-value 30.7 percent). I conclude that the two rice exchange prices are indeed not cointegrated.

I now return to the original 2005-09 sample and add the six national rice prices, one at a time, to give a trivariate VAR(2). Whereas in the case of maize, where the two exchange prices are cointegrated, I tested for $rank(\alpha\beta') = 2$, in rice, lacking this cointegration, I test for $rank(\alpha\beta') = 1$.

A cointegrating rank of one is established for Peru. For Viet Nam, the failure to reject $rank(\alpha\beta') = 0$ is marginal. The test outcomes are problematic for Kenya and Malawi where the test rejects $rank(\alpha\beta') \leq 1$ (marginally in the Kenyan case) which would imply all three prices are stationary, again contradicting the results of the ADF tests. However, if we override

Table 7.6: Statistical properties of rice price series: 2005-09

	Stationarity	Cointegration tests			Implied cointegrating vectors
		rank = 0	rank ≤ 1	rank ≤ 2	
Free market (Bangkok)	ADF (2) -1.12	12.8 [12.3%]	3.94 [4.7%]	-	0 (?)
Free market (Chicago)	ADF (1) -1.30				
Benin	ADF (2) 0.43	24.2 [19.9%]	6.59 [63.1%]	0.31 [57.5%]	0
Kenya	ADF (1) - 0.64	43.1 [0.1%]	11.2 [21.5%]	4.00 [4.6%]	1 (?)
Malawi	ADF (3) - 1.36	32.5 [2.3%]	12.7 [12.8%]	5.56 [1.8%]	1 (?)
Nepal	DF - 0.23	25.2 [15.8%]	5.80 [72.1%]	0.27 [60.2%]	0
Peru	ADF (1) - 1.19	31.8 [2.8%]	11.2 [20.3%]	3.70 [5.4%]	1
Viet Nam	ADF (1) - 0.89	28.6 [7.0%]	7.68 [30.6%]	2.28 [13.1%]	0 or 1
Average price	ADF (1) - 0.22	31.9 [2.8%]	9.37 [33.9%]	1.52 [21.8%]	1

Note: Sample period is March 2005 (rank tests; Nepal and Average – June 2005) and May 2005 (ADF tests; Nepal and Average – August 2005) – December 2009. The ADF lag was selected over the range 0-3 on the basis of the Akaike Information Criterion. 5 percent critical value is – 2.91. Cointegration is examined using the Johansen trace tests within a set of bivariate VAR(2) models considering the free market price with each of the other prices. The reported statistics test $rank(\alpha\beta') \leq 1$ $(r = 0,1,2)$. The final row considers cointegration among the three national prices. Tail probabilities in "[.]" parentheses.

this result, we again establish a cointegrating rank of unity. By contrast, cointegration is completely rejected in the case of Benin and Nepal where local prices continued to rise through 2009 while they fell back elsewhere - see Figure 7.6. The price constructed as the average of the six national prices does appear to be cointegrated with the two free market prices.[13]

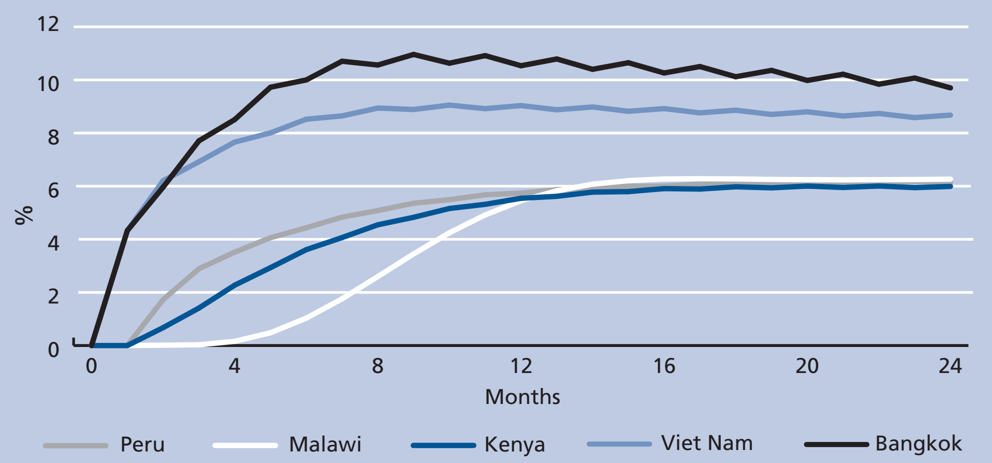
The results reported in Table 7.6 demonstrate possible links between the various national prices, with the exception of those of Benin and Nepal,[14] and the two world prices. To enable examination of these links in greater detail, I report the estimated α and β coefficients in Table 7.7.[15] The first two columns of the table test whether the β coefficients for respectively the Bangkok and Chicago prices can be set to zero. I fail to reject the hypothesis with respect to the Chicago price for Kenya and, marginally, for Viet Nam (column 2). The same hypothesis with respect to the Bangkok price is rejected for all four countries (column 1). The third and

13 This result is also problematic. If any one of the six prices composing the average is not cointegrated with the exchange prices, the average itself cannot be cointegrated. However, using relative short samples, apparently contradictory results of this sort can emerge.

14 Agricultural prices in Nepal relate to Indian prices in the first instance, and not to world prices.

15 Benin and Nepal are excluded because of lack of cointegration.

Figure 7.7: Impulse response functions: rice



fourth columns of the table report the estimated β coefficients, relative to a normalization of minus one on the coefficient of the national price. I set the coefficient β_{Ch} on the Chicago price to zero for Kenya and Viet Nam based on the test outcomes reported in column 2 and also for Malawi where $\beta_{Ch}$is estimated as negative. Similarly, I set $\beta_{Bk} = 0$ for Peru where this coefficient was estimated as negative. In summary, the Kenyan, Malawian and Vietnamese rice prices are seen as being cointegrated with the Bangkok price and the Peruvian price with the Chicago price. The final three columns give the estimated α coefficients. The size of these coefficients α_j shows the speed at which the national prices react to any discrepancy with respect to world prices. Reaction is seen as fastest in Viet Nam and slowest in Malawi.

The final row of Table 7.7 performs the same tests with respect to the average price (which includes the Beninois and Nepalese prices). As in the cases of Kenya and Viet Nam, we fail to reject the hypothesis that $\beta_{Ch} = 0$ so that the average world price is seen as being linked only to the Bangkok price. The estimated β_{Bk} coefficient is 0.75 so prices are seen as varying by 75 percent of those on the free market. The estimated α coefficients show that while the Bangkok and Chicago prices both react to the average world price, there is no evidence of any reaction of the world price to the exchange prices.[16]

The implication of these results is that, in the rice market, the prices taken as representing world prices follow prices in local markets round the world rather than vice versa. The CBOT price for rough rice does not appear to have major relevance to world markets. In line with the generally accepted view, the Bangkok spot price appears more important. Nevertheless, that price appears to be reacting to prices in producing and consuming markets rather than determining those prices. In terms of the literature in financial economics, price discovery appears to take place in the producing and consuming markets more than in centralized spot and futures markets. Instead of asking how fast and to what extent changes in world

[16] We also considered cointegration among the six national rice prices in the same way as for wheat. Tests indicated three cointegrating vectors but no simple identification appears available.

Table 7.7: Estimated maize VAR

	$\Delta\ln Pch_t$	$\Delta\ln Pky_t$	$\Delta\ln Pmw_t$	$\Delta\ln Ppy_t$
$\Delta\ln Pch_{t-1}$	0.239 (0.091)	0.045 (0.114)	0.398 (0.182)	0.202 (0.112)
$\Delta\ln Pky_{t-1}$		- 0.075 (0.091)		
$\Delta\ln Pmw_{t-1}$			0.412 (0.076)	
$\Delta\ln Ppy_{t-1}$				- 0.298 (0.086)
$\Delta\ln Pch_{t-2}$			0.082 (0.043)	0.249 (0.048)
$\Delta\ln Pmw_{t-2}$			- 0.096 (0.027)	
$\Delta\ln Ppy_{t-2}$				- 0.378 (0.069)
R2	0.057	0.007	0.336	0.236
Standard error	6.24%	7.60%	12.44%	7.57%
Autoregression LM (7)	F7, 109 = 1.29 [26.2%]	F7, 108 = 1.11 [36.2%]	F7, 106 = 1.77 [10.1%]	F7, 106 = 1.93 [7.26%]

prices are passed through into national prices, we should therefore ask the reverse question of pass-through from national to world prices. The picture we obtain is one of an imperfectly globalized market in which the prices taken as world prices relate to residual transactions and furthermore, these supposedly representative prices do not even move closely together.

The rice VAR model is more problematic than those for maize and wheat. The model takes Malawian rice prices to be cointegrated with those in Kenya and Kenyan and Peruvian prices to be cointegrated with the Vietnamese price which appears to play the role of the average price in the results reported in Table 7.6.[17] The Bangkok spot price is also specified as cointegrated with the Vietnamese price but with the error correction terms confined to the Bangkok equation. The dynamic part of the model relates the change in each price to its own lag and to either the lagged value of the Bangkok price or the Vietnamese price, depending which fits better. The resulting model is only borderline stable, and it was necessary to impose a unit cointegrating vector between the Bangkok and Vietnamese prices to ensure that all roots lie within the unit circle. The estimate model is reported in Table 7.9.

The impulse response consists of a 4.33 percent shock to each of the Bangkok and Vietnamese prices. Combined, these generate a 10 percent cumulative impact on the Bangkok price after six months. Prices both oscillate and overshoot with the maximum at six months for the Bangkok price and ten months for the Vietnamese price. Figure 7.7 charts the resulting rises in the four national prices. The Vietnamese responses closely track the changes in the

17 As each of the prices is seen as cointegrated with one of the other prices, any pair of prices must be cointegrated. However, statistically, one may fail to find cointegration with one choice of pairs while finding it with an alternative choice.

Table 7.8: Estimated wheat VAR				
	$\Delta \ln Pch_t$	$\Delta \ln Pky_t$	$\Delta \ln Pmw_t$	$\Delta \ln Ppy_t$
$\Delta \ln Pch_{t-1}$	0.239 (0.091)	0.045 (0.114)	0.398 (0.182)	0.202 (0.112)
$\Delta \ln Pky_{t-1}$		- 0.075 (0.091)		
$\Delta \ln Pmw_{t-1}$			0.412 (0.076)	
$\Delta \ln Ppy_{t-1}$				- 0.298 (0.086)
$\Delta \ln Pch_{t-2}$			0.082 (0.043)	0.249 (0.048)
$\Delta \ln Pmw_{t-2}$			- 0.096 (0.027)	
$\Delta \ln Ppy_{t-2}$				- 0.378 (0.069)
R2	0.057	0.007	0.336	0.236
Standard error	6.24%	7.60%	12.44%	7.57%
Autoregression LM (7)	F7, 109 = 1.29 [26.2%]	F7, 108 = 1.11 [36.2%]	F7, 106 = 1.77 [10.1%]	F7, 106 = 1.93 [7.26%]

Bangkok spot price but at around 80 percent of that level. The long run effects are similar in Kenya, Malawi and Peru with a pass through of 6 percent, i.e. 60 percent of the combined initial shock. Adjustment is seen as much slower in Malawi than either Kenya or Peru.

These results contrast with those obtained for both maize and wheat. As in wheat, but unlike maize, there is no pass-through from world prices to local prices. However, as in maize, but unlike wheat, price rises in world markets are associated with comparable, although in this case smaller, rises in rice prices in local markets. The Vietnamese price follows the Bangkok price quickly and relatively closely. Prices in Kenya, Malawi and Peru follow to a lesser extent and more slowly. However, the direction of impact appears to be from the national prices to the world price and not the reverse.

Rice is therefore a case of reverse pass-through (or "pass back"). It is acceptable to take movement in the Bangkok price as an indicator of movements in national prices but there is no basis for claiming that shocks to the Bangkok price, including those from possible interventions, would affect national rice prices. Trades on the Bangkok spot market do not determine rice transaction prices away from the market in the way that trades in the CBOT corn price and SAFEX maize price determine world maize transactions prices. Nevertheless, the Bangkok spot price may be seen as a price thermometer, but one which exaggerates changes in temperature.

Conclusions

The three grains considered present a contrasting picture. In all three cases, there are two recognized world prices one of which is generated in the Chicago futures markets. In each

Table 7.9: Estimated rice VAR

	$\Delta \ln Pbk_t$	$\Delta \ln Pvn_t$	$\Delta \ln Pky_t$	$\Delta \ln Pmw_t$	$\Delta \ln Ppy_t$
$\Delta \ln Pbk_{t-1}$	0.516 (0.117)	0.419 (0.069	0.156 (0.040)		
$\Delta \ln Pvn_{t-1}$	- 0.138 (0.194)	0.016 (0.113)		0.003 (0.094)	0.400 (0.181)
$\Delta \ln Pky_{t-1}$			-0.083 (0.126)		
$\Delta \ln Pmw_{t-1}$				0.485 (0.094)	
$\Delta \ln Ppy_{t-1}$					0.055 (0.123)
$\Delta \ln Pbk_{t-2}$	- 0.268 (0.070)				
$\Delta \ln Pvn_{t-2}$	0.268 (0.070)		0.124 (0.044)		0.073 (0.052)
$\Delta \ln Pky_{t-2}$			- 0.180 (0.061)	0.185 (0.044)	
$\Delta \ln Pmw_{t-2}$				- 0.176 (0.036)	
$\Delta \ln Ppy_{t-2}$					- 0.100 (0.050)
R2	0.410	0.461	0.337	0.560	0.158
Standard error	7.15%	4.24%	2.55%	3.84%	7.15%
Autoregression LM (4)	F4,49 = 1.27 [29.5%]	F4,51 = 0.80 [53.1%]	F4,49 = 2.67 [4.3%]	F4,49 = 2.21 [8.1%]	F4,49 = 1.78 [14.9%]

case, the two prices relate to different specifications - yellow versus white maize, soft versus hard wheat and (milled) white versus (unmilled) rough rice. The prices therefore differ both in terms of level and monthly changes. However, while the two maize prices are cointegrated and therefore tend back towards a time invariant proportion, there is no clear long term relationship between the two world prices in either the rice or the wheat markets. Furthermore, while maize prices do appear to be set on the major international world maize markets, rice prices appear to be determined in a decentralized manner in rice producing and consuming countries.

Standard pass-through models work well for maize. Kenya is seen as having largely insulated itself from changes in world maize prices, but, despite its efforts, Malawi has failed to do so.[18] The same pass-through models work poorly for wheat and rice. In the case of wheat, the various national prices move together but do not move with the two exchange

18 Daviron (2008) stresses "*une dynamique propre et endogène des marchés des céréales locales*" which results in a "*forte instabilité*". The clear local dynamic is evident in our results for Benin, Kenya and Malawi, but the high volatility only in Malawi.

prices. In the case of rice, transmission is largely in the opposite direction from that supposed in those analyses.

These findings are corroborated by estimated VAR models which reflect the cointegration structure in the variables. Pass through is high and relatively rapid in maize, mixed and complicated in rice and very low in wheat. On the basis of the evidence analysed in this chapter, the world maize market appears integrated while the wheat market does not. The world price is relevant to national prices in maize but does not appear so in wheat. Rice shows evidence of a high degree integration across national markets but in which the supposed world prices play little role. The important prices appear to be the transactions prices of major exporters, such as Viet Nam, and not exchange spot prices.

In policy terms, this analysis indicates caution in interpreting the implications of movements in so-called world prices in relation to the prices paid by consumers and received by farmers in developing countries. We have seen that the extent and speed of pass-through varies both over grains and over countries. The world maize market appears the best integrated of the three markets considered and transmission was both high and rapid for Malawi and Peru, but absent in Kenya where government has succeeded in stabilizing domestic prices, albeit at a high level. The wheat market appears the least well integrated of the three - local wheat and wheat flour prices followed the upward but not the downward movement in world prices (see on this issue Box 3.3 and Stigler & Tortora, 2011). The reasons for this, and the extent to which it was also true in other countries, deserves further examination. Rice is a puzzling intermediate case - the various national prices do appear to move together, both on the way up and the way down, but do not do so in relation to the standard (Bangkok) world reference price which is more volatile than national prices and tends to follow rather than lead these prices.

It follows that policies which directly address world markets, such as a world grain stockpile or actions to curtail supposedly excessive futures market activity, might hope to reduce the volatility of world maize prices, but the effects of these policies on national wheat and rice prices is more difficult to predict. In any case, such direct intervention may be unnecessary and perhaps over costly if countries are able to insulate their domestic prices from movements in world markets, as appears to have been the case with maize in Kenya. This suggests that it may be better to address food security and food safety nets on a country-by-country basis so that policies can be adapted to the severity of the food price problem in each country and to local conditions. Grand schemes attract political attention but, in the view of the author of this chapter, more is to be gained from hard work at the country level.

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Chapter 8

Price transmission and volatility spillovers in food markets

George Rapsomanikis[1]

This chapter focuses on assessing the persistence of food price volatility and the mean and volatility spillover between world food markets and the markets of selected developing countries. Spillover in the mean denotes the transmission of price changes from the world to domestic prices and vice versa in terms of levels. Volatility spillover reflects the comovement of the price variances in these markets. A better understanding of the price mean and variance relationships between the world market and the markets of developing countries can assist policy formulation. Increases in food price volatility have important negative implications for economic welfare in developing countries where agricultural commodities form the basis for household income and food consumption.

Chapter 2 identifies that commodity prices in general, both at the world and domestic markets, tend to be non-stationary processes that are integrated of order one. Non-stationarity implies that shocks to the series are permanent, rendering the mean dependent on time. In addition to this property, the first differences of commodity prices often tend to be leptokurtic. This is indicative that shocks result in volatility clustering, suggesting that the variance may be also time variant. In this chapter, I model price transmission, or mean spillover, within a Vector Error Correction (VECM) framework. This allows us to reveal the dynamics of adjustment of prices to their long-run equilibrium relationship. The analysis of volatility spillover is based on the application of multivariate Generalized Autoregressive Heteroscedasticity (GARCH) on the innovations of the VECM. GARCH models were introduced by Engle (1982) and generalized by Bollerslev (1986) and take into account that variances vary over time. Although there are many applications of vector autoregressions and GARCH models in the finance literature (see for example De Goeij & Marquering, 2004; Hassan & Malik, 2007; Qiao et al., 2008; and Alizadeh et al., 2008), such analyses are uncommon in agricultural economics.

I study food markets in six different developing countries. I analyse the relationship between the world market and the wheat market in Peru and the maize market in Mexico. In Asia, I investigate price transmission and volatility spillover in the rice markets of India and the Philippines. I also select two African markets, maize in Malawi and sorghum in the Niger.

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Background

Sustained food price increases will have a significant impact on the rate of poverty incidence. A number of studies suggest that most of the poor are net consumers of food and therefore, are adversely affected by the food price upswing (Poulton et al., 2006 and Christiaensen & Demery, 2006). Poor rural households are often characterized by a lack of, or insignificant, marketed surplus. Small land assets and limited access to inputs owing to cash constraints, as well as limited access to output markets because of distance and poor infrastructure contrive to the households being predominantly net buyers of food. A number of researchers have attempted to measure the implications of food price surges for poverty in developing and less developed countries (Ivanic & Martin, 2008; Polaski, 2008; Wodon et al., 2008; and Rapsomanikis, 2009). These analyses utilize several different methodologies and apply them to household survey data from a number of developing countries. As highlighted in Chapter 3, increases in food prices will have very diverse effects across countries, depending on the structure of the economy, the linkages of agriculture with other sectors, the households' net position towards food markets, as well as the distribution of households around the poverty threshold. Nevertheless, in most cases increases in poverty occur more frequently than reductions. In general, the results suggest that, on average, food price surges result in increased poverty.

Persistent price volatility, especially in the presence of liquidity constraints and inadequate assets can result in economic inequality within rural populations and create poverty traps (Zimmerman & Carter, 2003). Households minimize their exposure to risk from such covariate shocks by developing risk management strategies, such as crop and income diversification, and attempt to develop self-insurance by smoothing consumption. The diversification of activities inhibits efficiency gains from specialization in production and hinders the development of the agricultural sector (Carter, 1997; Kurosaki & Fafchamps, 2002). Income risks may also blunt the adoption of technologies necessary for agricultural production efficiency, as producers may decide to apply less productive technologies in exchange for greater stability (Larson & Plessman, 2002).

A fundamental issue when analyzing the impact of food price episodes on developing countries is the extent to which prices in developing countries respond to price shocks in the international market. Price transmission between food markets is central in assessing the impact on producers and consumers and understanding how they adjust to price shocks. In general, the absence of market integration, or of complete pass-through of price changes from one market to another has important implications for economic welfare. Most developing countries are subject to incomplete price transmission either owing to trade and other policies, or to high transaction costs arising from poor transport and communication infrastructure. In general, poor transmission results in a reduction in the price information available to economic agents and leads to decisions that contribute to less elastic demand and supply responses.

The transmission of prices and the spillover of volatility

Across countries, domestic prices for food exhibit diverse patterns of price transmission from international prices. Often, the impact of international prices on the markets of developing countries is either small or delayed, and producers and consumers are subject to price variability that arises owing to domestic shocks (Rapsomanikis & Sarris, 2008). Food prices exhibit wide variability owing to seasonality, climatic phenomena and poor infrastructure that does not facilitate the transport of food from surplus to deficit areas. During periods of international market tranquillity, increased exposure to global markets could result in a reduction in food price volatility, as international markets may act as a "buffer" absorbing large domestic supply and demand shocks. Imperfect price transmission may, to a certain extent, shield some countries from external shocks, while significantly affecting both the price level and volatility in others. This poses a policy dilemma highlighting the need for policies to achieve market integration and mitigation of the negative effects of price surges.

Studies on the transmission of price signals are based on the concept of competitive pricing. The classical paradigm of the Law of One Price suggests that, in the long run, price transmission is complete with prices of a commodity sold on competitive foreign and domestic markets differing only by transport costs. Such a complete price pass-through is attained through trade and reflects the integration of markets. Changes in supply and demand in one country will affect prices that will in turn instigate trade with other countries. Just as arbitrage and trade restores the market equilibrium, prices in the domestic market tend to equalize with those in foreign markets except for transport costs - hence the term "Law of One Price".

In practice, price transmission can be slow, or far from complete owing to a number of reasons including the implementation of policies, transport costs, non-competitive supply chains and consumer preferences. The implementation of ad valorem import tariffs or export taxes allows international price changes to be fully transmitted to domestic markets in proportional terms in the absence of other costs. Nevertheless, prohibitively high tariffs or taxes eliminate opportunities for arbitrage and result in domestic and international prices moving independently of each other, as if an import or export ban were implemented.

In the context of food price hikes, many governments in developing countries have implemented short-run border measures, such as import tariff reductions or exports bans, in order to curb domestic price increases and shield consumers from increased food expenditure. Such decreases in import tariffs facilitate price transmission, especially if tariffs were initially set at high levels. For food exporters, export bans, if effective, hinder the transmission of price signals from the international market and prevent the domestic price level from rising.

Policies that aim to stabilize domestic prices at a certain level are often implemented in conjunction with border measures. Government intervention in the form of food commodity procurement or sale and inventory management is commonly practiced across African and Asian countries. Such policies impede price transmission depending on the government's price targets, its capacity and budget to realize food purchases at certain price levels and its ability to manage food inventories and trade continuously. Even then, depending on domestic market fundamentals, trade takes place and the international and domestic prices may not be completely unrelated, with the intervention policy resulting only in weak international price pass-through.

Apart from policies, domestic markets can also be insulated by large margins that arise because of high transport and marketing costs. Especially in developing countries, poor infrastructure, transport and communication services give rise to significantly high costs of delivering the locally produced commodity to the border for export or the imported commodity to the domestic market for consumption. Such high margins hinder the transmission of price signals. As a consequence, changes in international prices are not fully transmitted to domestic prices, resulting in producers and consumers adjusting only partly, if at all, to shifts in global supply and demand.

Oligopolistic behaviour and collusion among domestic traders may keep price differences between international and domestic prices on levels higher than those determined by transport costs. Concentration in the food marketing and processing sectors and imperfectly competitive behaviour beyond the farmgate implies that processors or middlemen may have power over prices. Therefore, they may exercise pricing strategies that result in a quick and complete pass-through of increases in the international price and a slow and incomplete transmission of decreases in the international price to domestic prices upstream as their margins are squeezed.

Consumer preferences may also result in incomplete price transmission even under competition and free market conditions. Domestically produced food often has different attributes than those characterizing internationally traded food commodities. If consumers preferred the attributes of the domestically produced food, the possibilities of substitution in consumption between domestic and imported foods would be limited. For example, in Eastern and Southern Africa, as well as in Mexico, consumers generally prefer white maize rather than the internationally traded yellow maize. As consumers are unwilling to substitute one type of maize for another, domestic prices may depend mainly on regional supply and demand shocks for white maize rather than global market conditions. If transmission were found incomplete, some white maize producing countries may have experienced increases that are attributable to domestic market fundamentals and not to the upturn of the international price of yellow maize.

Across developing countries, these factors have a diverse effect on the transmission of international price to both the domestic price level, as well as the volatility around this level. Rapsomanikis & Sarris (2008) find that a large part of the domestic price and the agricultural income variability in Peru and Viet Nam is because of domestic shocks. While domestic prices for tradable agricultural commodities exhibit diverse patterns of price transmission from international prices, the impact of international prices is found to be small, mainly because of imperfect pass-through from the international markets.

Rapsomanikis and Sarris' empirical work provides some answers related to the impact of total exposure to international prices on income variability. In general, their results suggest that, during periods of relative international market tranquility, increased exposure to international markets may result in a reduction in agricultural income volatility, as international markets may act as a "buffer" absorbing domestic shocks. For example, in Malawi during the last decade, prices of maize, the locally produced main staple, exhibited extreme spikes in the beginning of 2002 and during the first months of 2006, both periods characterized by calm international maize markets. During the 2008 food price surge, the Malawian price spike was more pronounced in both magnitude and duration as compared with the surge in international price. Between 2000 and 2010, prices of wheat, a mainly imported food, in Peru exhibited frequent bouts of volatility, resulting in significant price spikes, as in 2003. However, as in the case of maize in Malawi, the 2008 food price surge was transmitted to the Peruvian food markets and brought prices to the highest level of the last decade.

The model

Given prices for a commodity in two spatially separated markets pdt and pwt, the Law of One Price and the Enke-Samuelson-Takayama-Judge model (Enke, 1951; Samuelson, 1952; and Takayama & Judge, 1971) postulate that at all points of time, allowing for transfer costs

m, for transporting the commodity from one market to another, the relationship between the prices is as follows:

$$p_{1t} = p_{2t} + m \tag{1}$$

If a relationship between two prices, such as (1), holds, then the markets can be said to be integrated. However, this extreme case is unlikely, especially in the short run. At the other end of the spectrum, if the joint distribution of two prices were found to be completely independent, then one might feel comfortable saying that there is no market integration and no price transmission. In general, spatial arbitrage is expected to ensure that prices of a commodity will differ by an amount that is at most equal to the transfer costs with the relationship between the prices being identified as the following inequality:

$$p_{2t} - p_{1t} \leq m \tag{2}$$

Fackler & Goodwin (2002) refer to the above relationship as the spatial arbitrage condition and postulate that it identifies a weak form of the Law of One Price, the strong form being represented by equality (1). They also emphasize that relationship (2) represents an equilibrium condition. Observed prices may diverge from relationship (1), but spatial arbitrage will cause the difference between the two prices to move towards the transfer cost. The condition encompasses price relationships that lie between the two extreme cases of the strong form of the Law of One Price and the absence of market integration. Depending on market characteristics, or the distortions to which markets are subjected, the two price series may behave in a plethora of ways, having quite complex relationships with prices adjusting less than completely, or slowly rather than instantaneously and according to various dynamic structures, or being related in a non linear manner.

Within this context, complete price transmission between two spatially separated markets is defined as a situation in which changes in one price are completely and instantaneously transmitted to the other, as postulated by the Law of One Price presented by relationship (1). In this case, spatially separated markets are integrated. In addition, this definition implies that if price changes are not passed-through instantaneously but after some time, price transmission is incomplete in the short run but complete in the long run, as implied by the spatial arbitrage condition. The distinction between short-run and long-run price transmission is important and the speed by which prices adjust to their long-run relationship is essential in understanding the extent to which markets are integrated in the short run. Therefore, there are various reasons that price changes at one market may need some time to be transmitted to other markets such as policies, the number of stages in marketing and the corresponding contractual arrangements between economic agents, storage and inventory holding, delays caused in transportation or processing or "price-levelling" practices.

The spatial arbitrage condition implies that market integration lends itself to a cointegration interpretation with its presence being evaluated by means of non-cointegration tests. Cointegration can be thought of as the empirical counterpart to the theoretical notion of a long-run equilibrium relationship. If two prices in spatially separated markets p_{1t} and p_{2t}, contain stochastic trends and are integrated of the same order, say I(d), the prices are said to be cointegrated if:

$$p_{1t} - \beta p_{2t} = u_t \tag{3}$$

where u_t is stationary and β is the cointegrating parameter. Evidence for cointegration reflects that prices are jointly determined. The concept of cointegration has an important implication purported by the Granger Representation Theorem (Engle & Granger, 1987). According to this theorem, if two trending, say I(1), variables are cointegrated, their relationship may be validly described by a VECM and vice versa. In the case that prices from two spatially separated markets are cointegrated, the VECM representation is as follows:

$$\Delta p_t = \mu + \Pi p_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta p_{t-i} + v_t \tag{4}$$

where $v_t|\Omega_{t-1} \sim \mathcal{N}(0, H_t)$ are normally distributed disturbances conditional on past information with zero mean and a variance-covariance matrix denoted by H_t, while the operator Δ denotes that the I(1) variables have been differenced in order to achieve stationarity. Πp_{t-1} states the long run relationship while the matrix P can be decomposed in $\Pi = \alpha\beta'$ as follows:

$$\begin{pmatrix} \Delta p_{1t} \\ \Delta p_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} (p_{1t-1} - \beta p_{2t-1}) + \sum_{i=1}^{k} \Gamma_i \begin{pmatrix} \Delta p_{1t-i} \\ \Delta p_{2t-i} \end{pmatrix} + \begin{pmatrix} \nu_{1t} \\ \nu_{2t} \end{pmatrix} \tag{5}$$

The inclusion of the levels of the prices alongside their differenced terms is central to the concept of the VECM. Parameters contained in matrices Γ_i measure the short run effects, while β is the cointegrating parameter that characterizes the long-run equilibrium relationship between the two prices. The levels of the variables enter the VECM combined as the single entity $(p_{1,t-1} - \beta p_{2,t-1})$ that reflects the errors or any divergence from this equilibrium and correspond to the lagged error term of equation (3). The vector $(\alpha_1, \alpha_2)'$ contains parameters, commonly called error correction coefficients, which measure the extent of corrections of the errors that the market initiates by adjusting the prices towards restoring the long-run equilibrium relationship. The speed with which the market returns to its equilibrium depends on the proximity of α_i to unity. Within this context, short run adjustments are directed by, and consistent with, the long run equilibrium relationship, allowing the researcher to assess the speed of adjustment that shapes the relationship between the two prices.

The model also allows to test for causality in the Granger sense, providing evidence regarding which direction price transmission is occurring, as well as the decomposition of the forecast error variance in parts that are owing to international and domestic shocks respectively. The cointegration-VECM framework takes into account that prices are stochastic processes that have time-dependent means, and replicates their systematic behaviour being essentially a description of the conditional process of realizing the data.

While the VECM provides the conditional expected means of the variables, in order to examine for higher moment relationships that reflect volatility spillovers, the VECM's errors v_t are specified as a bivariate GARCH model (Bollerslev, 1986). I employ the Full Term (BEKK) parameterization by Engle & Kroner (1995), which incorporates quadratic forms in such a way so that the covariance matrix is positive semi-definite, a requirement that is necessary for the estimated variances to be non-negative. The BEKK parameterization is given by:

$$H_{t+1} = C'C + B'H_tB + A'\nu_t\nu_t'A \tag{6}$$

where H_{t+1} is the conditional variance matrix, C is a 2×2 lower triangular matrix with three parameters and B and A are 2×2 matrices of parameters restricted to be diagonal. In this parsimonious specification the conditional variances are a function of the lagged conditional variances and error terms. Expanding equation (6) gives the variance-covariance equations:

$$\begin{aligned} h_{11,t+1} &= c_{11} + b_{11}^2 h_{11t} + a_{11}^2 v_{1t}^2 \\ h_{22,t+1} &= c_{22} + b_{22}^2 h_{22t} + a_{22}^2 v_{2t}^2 \\ h_{12,t+1} &= c_{12} + b_{12}^2 h_{12t} + a_{12}^2 v_{1t} v_{2t} \end{aligned} \tag{7}$$

where $b_{12}^2 = b_{11}^2 b_{22}^2$ and $a_{12}^2 = a_{11}^2 a_{22}^2$. The b_{ii}^2 measure the extent to which current levels of conditional variances are related to past conditional variances. The a_{ii}^2 assess the correlations between conditional variances and past squared errors reflecting the impact of shocks on volatility. This specification does not arise from economic theory. However, it retains the intuition and interpretation of the univariate GARCH model and provides a good basis to model time varying volatility and heteroscedasticity, which is typically found in prices of assets and commodities.

Univariate GARCH models have been proved successful in predicting volatility that is clustered over time. Unexpected news, reflected in the specification by the lagged errors v_t tends to affect the variance of prices, with "good news", reducing volatility and "bad news" resulting in volatility increases. Often, in times of crisis, volatility not only increases but clusters. Especially in times of price surges, large variances tend to be followed by large variances, giving rise to periods characterized by high volatility. Such a phenomenon may be owing to "herd-like" behaviour where market agents pay less attention to market fundamentals and trade following the price trend. In the model, volatility clustering is captured by specifying the variance being determined by its past behaviour as reflected by the lagged h_t.

Multivariate GARCH models, such as BEKK, allow the modelling of temporal interactions between shocks in different markets by means of the estimation of the conditional covariance, $h_{12,t+1}$. This allows not only the examination of the impact of news on the covariances, but also the assessment of time-varying correlations between the shocks in different markets and the extent to which volatility spills over.

Empirical results

Data and preliminary analysis

I use logarithmic transformations of monthly domestic prices measured in USD per tonne from January 2000 to December 2009. The data on domestic prices are collected from FAO's Global Information and Early Warning System. Data on the corresponding international market prices are collected from the IMF's International Financial Statistics database.

I apply the VECM-BEKK model to investigate spillover between the world market and the wheat market in Peru and the maize market in Mexico. In Peru, wheat and wheat products accounted for 11 percent of the total dietary energy supply in 2003-05. Peru relies mainly on wheat imports. On average in 2004-08, the self-sufficiency ratio of wheat and wheat products was 11 percent. In Mexico, white maize is the main staple food while yellow maize is imported for animal feed. Average 2004-08 per capita annual food consumption of maize and maize products was 140 kg. During the same period, the self-sufficiency ratio of maize and maize products was 75 percent.

I focus on Asia, investigating price transmission and volatility spillover in the rice markets of India and the Philippines. India is a major producer and exporter of rice. It is fully

Table 8.1: Food prices: tests for non-stationarity

	Augmented Dickey Fuller		Phillips - Perron	
	p_t	Δp_t	p_t	Δp_t
Peru -wheat	-0.23-	-9.89	-3.30	-11.75
Mexico - maize	-1.01	-6.11	-1.04	-10.53
India -rice	-0.48	-12.31	-0.12	-12.46
Philippines - rice	-1.50	-9.30	-1.49	-9.44
Malawi - maize	-3.08	-7.01	-2.23	-6.67
Niger - sorghum	-2.29	-7.90	-2.60	-7.13
World market -wheat	-1.67	-8.56	-1.66	-8.58
World market –rice	-0.51	-6.77	-0.48	-6.32
World market – maize	-1.36	-8.42	-1.31	-8.42
World market - sorghum	-1.27	-9.33	-1.52	-9.37

Note: The 5 percent and 1 percent critical values for both tests are -2.88 and -3.48, respectively.

self-sufficient in rice, which is the main staple food throughout the country. Rice accounted for 30 percent of the total dietary energy supply in 2003-05. In the Philippines, where rice is also the main staple, the self-sufficiency ratio of rice was, during the 2004-08 period, about 85 percent.

I also select two African food markets, those of maize in Malawi and sorghum in the Niger. In Malawi, maize is the main staple food produced and consumed throughout the country. Maize and maize products accounted for 52 percent of the total dietary energy supply in 2003-05. On average in 2004-08, per capita annual consumption of maize was 127 kg. The self-sufficiency ratio of maize was 97 percent. Sorghum is one of the main staple foods in the Niger, accounting for 12 percent of the total dietary energy supply in 2003-05. On average in 2004-08, per capita annual consumption of sorghum was 43 kg.

The order of integration of the price series is assessed by the Augmented Dickey Fuller (ADF) test (Dickey & Fuller, 1979) and the Z_r test by Phillips & Perron (1998). All series were found to be non-stationary and integrated of order 1 (Table 8.1).

Table 8.2 presents a range of descriptive statistics for the differenced prices Δp_t. The sample moments for all differenced prices indicate non-normal distributions. Zero excess kurtosis is rejected for all series suggesting leptokurtic distributions with heavy tails. In general, the statistics indicate that the differenced prices exhibit time-varying variance and volatility clustering with large changes being likely to be followed by further large changes.

The Jacque-Bera test is used to test the hypothesis that the differenced prices are normally distributed. In all cases, the probability values are smaller than 0.01, rejecting the null. I also calculated the sample autocorrelation functions, which provided evidence for autocorrelation, at least for the first and the second lag.

Empirical results

VECMs: Price transmission or mean spillover

For each of the food markets, I test for cointegration between the domestic and world prices using the Full Information Maximum Likelihood method developed by Johansen (1995). This

Table 8.2: Differenced food prices: descriptive statistics									
	Wheat		Rice			Maize		Sorghum	
	Peru	World	Philippines	India	World	Malawi	World	Niger	World
Mean	0.007	0.006	0.004	0.004	0.008	0.005	0.005	0.011	0.005
Median	0.002	0.002	0.006	0.004	0.003	0.013	0.004	0.014	0.005
Maximum	0.644	0.229	0.174	0.246	0.412	0.484	0.167	0.259	0.189
Minimum	-0.621	-0.219	-0.105	-0.319	-0.190	-0.705	-0.246	-0.623	-0.278
Standard Deviation	0.169	0.065	0.031	0.055	0.068	0.177	0.063	0.129	0.069
Skewness	0.670	-0.048	1.338	-0.880	2.541	-0.773	-0.645	-1.2667	-0.693
Kurtosis	8.008	4.913	12.959	14.380	16.706	5.483	5.106	7.175	5.208
Jarque-Bera	133.256	18.197	527.352	657.530	1 059.564	42.427	30.256	118.291	33.705
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Ljung-Box lag=1	-0.204	0.225	0.520	0.234	0.493	0.404	0.238	0.353	0.142
	0.024	*0.013*	*0.000*	*0.010*	*0.000*	*0.000*	*0.009*	*0.000*	*0.081*
Ljung-Box lag= 2	-0.155	0.065	0.184	-0.004	0.075	0.034	0.049	-0.099	0.056
	0.018	*0.035*	*0.000*	*0.032*	*0.000*	*0.000*	*0.027*	*0.000*	*0.241*

Note: Probabilities in italics.

test is based on the rank of matrix P in equation (4) and is the most commonly encountered in the price transmission literature. A rank equal to zero indicates non-cointegration. In our bivariate case, a rank of one would suggest cointegration between the domestic and world prices. For $n+1$ variables Johansen derived the distribution of two test statistics for the null of at most n cointegrating vectors referred to as the Trace and the Eigenvalue tests.

Table 8.3 presents the results of the non-cointegration Trace tests for the food markets under consideration. In all cases, there is strong evidence that the domestic prices and the world prices are cointegrated, with the Johansen test rejecting the null of no cointegration, but failing to reject the null of one cointegrating vector. These results suggest that the domestic markets of these commodities are well integrated with the world markets in the long run.

I formulate VECMs in order to assess the dynamics and the speed of adjustment. The estimated VECMs are presented in Table 8.6. For the Peruvian wheat market, the estimated ECM suggests that the adjustment process of the domestic price to the world price is fast. On average, over the 2000-09 period, about 0.40 percent of the divergence of the domestic wheat price from its notional long run equilibrium with the world price is corrected each month. This reflects that wheat prices in Peru adjust fully to price changes in the international market in just over two months. The non-significant error correction coefficient in the world price ECM suggests that the world price is weakly exogenous, identifying a causal relationship, in the Granger sense, which runs from the world to the Peruvian market, as expected for a small importing country. For the Mexican maize market, the error correction coefficient indicates that each month about 12 percent of the divergence of domestic prices from their long run equilibrium is corrected. On average during the past decade, it would take some ten months for maize prices in Mexico to fully adjust to a change in the international maize price.

Table 8.3: Trace statistic tests for cointegration in food markets

	Number of cointegrating vectors:		Cointegrating vectors	
	0	1	Domestic price	World price
Peru – wheat	16.03	2.47	1	-1.24
Mexico – maize	14.04	1.48	1	-0.62
India – rice	18.50	0.03	1	-0.47
Bangladesh – rice	22.09	0.11	1	-0.43
Malawi – maize	14.22	2.60	1	-0.81
Niger – sorghum	14.62	2.28	1	-0.72

Note: In all cases the critical values for no cointegration and one cointegrating vector at the 5 percent level are 15.49 and 3.84 respectively. The appropriate lag length was chosen on the basis of the Schwartz-Bayes information criterion.

The statistical significance of both error correction coefficients in the Indian-world rice market VECM suggests that both prices are endogenous, with the world price or rice influencing the Indian market price and vice versa. This is not surprising, given the importance of India in the world rice market. The results indicate that both the Indian and the world prices adjust to their long run equilibrium, correcting about 16 percent of the divergence each month. Such a low rate of adjustment between the Indian and international rice prices can be attributed to policies such as public procurement and reserve management implemented by the Indian government to ensure food security, as well as to provide incentives to rice farmers. The estimated error correction coefficients in the Philippines rice price VECM suggest that the international price is weakly exogenous. Rice prices in the Philippines adjust to international market changes relatively rapidly, with about 20 percent of the divergence from the long run equilibrium being corrected each month.

Maize is an important staple food in Malawi. The estimated VECM suggests that the world maize price is the long-run driver of the price of maize in Malawi. The domestic maize price adjusts to changes in the world maize price quite slowly. About 11 percent of divergences from the long-run path are corrected during the period of one month. A similar speed of adjustment is estimated for the sorghum price in the Niger. In both of these countries, the food prices under examination will fully adjust to changes in the international prices in a period equal to approximately ten months.

BEKK: Conditional variances or volatility spillover

The estimation of the BEKK parameterization of the multivariate GARCH is carried out by maximizing the conditional non-linear log-likelihood function following Engle & Kroner (1995). The numerical maximization method used was the Berndt, Hall, Hall and Hausman (BHHH) algorithm. The Schwartz-Bayes criterion was used to choose the appropriate lag length. The estimated parameters are shown in Table 8.4.

The estimated parameters of the own lagged innovations quantify the effects of "news" on the variances (ARCH effects), while the parameters of the lagged variances measure the extent of volatility clustering (GARCH effects) and thus reveal the persistence of volatility. The covariance equations capture the volatility spillovers between the domestic food markets under consideration and the world market. On the whole, the parameters are significant, indicating the presence of strong ARCH and GARCH effects.

Table 8.4: Estimated multivariate GARCH model

	Peru-world (wheat)	Mexico-world (maize)	India-world (rice)	Philippines-world (rice)	Malawi-world (maize)	Niger – world (sorghum)
c_{11}	0.004	0.001	0.000	0.000	0.007	0.000
	0.000	*0.000*	*0.118*	*0.087*	*0.344*	*0.327*
v^2_{1t-1}	0.857	0.371	0.431	0.561	0.077	0.356
	0.000	***0.0036***	***0.000***	***0.000***	***0.073***	***0.000***
h_{11t-1}	0.293	0.004	0.566	0.362	0.619	0.662
	0.000	*0.937*	*0.000*	*0.000*	*0.001*	*0.000*
c_{22}	0.000	0.000	0.000	0.000	0.000	0.002
	0.190	*0.725*	*0.454*	*0.257*	*0.455*	*0.262*
v^2_{2t-1}	0.114	0.07	0.358	0.089	0.125	0.8841
	0.001	*0.075*	*0.000*	*0.000*	*0.000*	*0.000*
h_{22t-1}	0.496	0.910	0.517	0.867	0.824	0.025
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.471*
c_{12}	0.000	0.000	0.000	0.000	0.000	0.002
	0.711	*0.725*	*0.001*	*0.251*	*0.224*	*0.005*
v^2_{1t-1} v^2_{2t-1}	0.312	0.167	0.393	0.223	0.098	-0.561
h_{12t-1}	0.496	0.062	0.541	0.530	0.824	0.128

Note: Probabilities in italics.

In all developing markets volatility, as reflected by the conditional variances, is shown to be persistent. Persistence can be measured by sum of the ARCH and GARCH coefficients, $b^2_{ij} + a^2_{ij}$, which, with the exception of the maize market in Mexico, is either close to or over unity. In all covariance equations, with the exception of the sorghum market in the Niger, the estimated parameters of the cross past innovations $v^2_{1,t-1}$ and $v^2_{2,t-1}$ are positive, suggesting that if shocks in the domestic and world markets have the same sign, the covariance will be affected in a positive manner reflecting the possibility for volatility spillover between the domestic and world markets under consideration.

Rather than focusing on the parameters themselves, I discuss the time plots of the estimated conditional variances over the period 2000-09. I also calculate the conditional

Table 8.5: World wheat and maize price conditional variances			
World price conditional variance	Constant	Trend	R2
Wheat	0.002 *5.246*	0.035 *7.897*	0.35
Maize	0.001 *3.893*	0.048 *9.297*	0.46

Note: *t*-ratios in italics.

correlation as follows:

$$\rho_{12,t+1} = h_{12,t+1} / \left(\sqrt{h_{11,t+1}} \sqrt{h_{22,t+1}} \right) \tag{8}$$

Figures 8.1 to 8.6 present the conditional variances and correlations of the markets examined. The plots show that the conditional variances and correlations of food commodities in all markets are far from being constant over time. The conditional variances of the world wheat and maize prices appear to follow a positive trend, suggesting that volatility in these markets has been steadily increasing during the 2000-09 period.

I then regressed both conditional variances on a time trend to corroborate this observation. In both regressions, the estimated time trend parameter was statistically significant (see Table 8.5). While on the other hand, the variances of the domestic food prices do not appear to follow a trend; most tend to cluster during the 2008-09 period following, to differing degrees, the world price volatilities. The conditional correlations are extremely variable, changing from negative to positive sign quite frequently, as well as from a low to high value in an abrupt way. This suggests a weak relationship between shocks in the international market and the markets of developing countries.

The conditional variance of the Peruvian wheat price is characterized by dramatic increases in 2000, the first months of 2004, as well as the end of 2008 and the first months of 2009, suggesting volatility spillover from the international market (Figure 8.1). It is worth noting that during this period, the conditional variance is at least 60 percent higher than its estimated values during 2004, suggesting that the food commodity price episode did not only lead to a delayed volatility clustering in the wheat market of Peru, but that its effect was probably exacerbated by domestic factors. Although in general, during the 2000-09 period, the volatility faced by wheat producers and consumers in Peru was, at times, significantly higher that that of the international wheat market, the recent price surge has affected the price variance in a disproportionate manner. The estimated conditional correlation exhibits sudden changes, ranging from 0.36 to 0.4 during 2000-09, revealing, on average, a weak relationship between international and domestic market shocks.

Although the estimated conditional variance of the world maize price follows an increasing trend since 2005, maize prices in Mexico are characterized by sudden bouts of volatility which at times (such as late 2001, summer 2003 and the first months of 2003) result in higher variances that those prevailing in the world maize market (Figure 8.2). The estimated price conditional variance also suggests that domestic maize prices were subject to high volatility during the recent price episode, indicating that volatility spilled over from the international to the Mexican market.

During this period, the Mexican Government pursued public-private partnerships and announced a price freeze on 150 basic-basket food products until the end of 2008 as part of

Figure 8.1: Peruvian and world wheat prices: domestic price conditional variance, world price conditional variance and conditional correlation

an agreement with the National Confederation of Chambers of Industry (Concamin). Food processors affiliated with the largest Mexican industrial trade groups agreed not to pass on their rising production cost to consumers, enabling the government to achieve price controls without direct economic intervention. Nevertheless, as in the case of Peru, the conditional variance of domestic maize prices since the summer of 2008 attained its highest values since 2000. This, in conjunction with high and positive values of the estimated conditional correlation, indicates that during times of high international price volatility there is significant and persistent volatility spillover onto the Mexican maize market.

Both the world and the Indian rice markets appear to be characterized by very low volatility up to the year 2007 (Figure 8.3). Indeed, since the mid-1980s, prices have been low and quite stable (Dawe, 2002). The world rice market is quite thin, with only about 7 percent of world production being traded, while all major producers manage their domestic markets mainly through trade policy measures. The Indian government intervenes in the rice market through procurement, stocking and distribution policies (Gulati & Dutta, 2010). The conditional variance of the Indian market prices exhibits sharp spikes in 2002-03 (owing to climatic conditions during that harvest period) and in 2008 (during the food price surge). These price hikes were however, to a certain extent, much lower that those of the international prices.

The conditional correlation of the Indian and world rice prices assumes positive values for most of the 2000-09 period and also exhibits sharp increases during 2002-03 and, most importantly during the 2008 price surge, indicating volatility spillovers. Although our findings indicate significant volatility persistence and spillover, volatility in the Indian market was significantly lower than in the world market during the recent price episode owing to the Government of India's intervention in stabilizing the domestic price level. Indeed, during the 2008 price surge, the imposed rice export ban resulted in less domestic price volatility in India, while at the same time other major rice exporting countries imposed export restrictions and the world price of rice increased sharply and became more volatile.

Figure 8.4 presents the conditional variance and correlations for the price of rice in the Philippines. While domestic prices are characterized by low volatility during the period 2000-07, the conditional variance exhibits a dramatic increase during the first quarter of 2008. This increase in variance is proportionately similar to the increase in variance of the world price with the conditional correlation between the world and domestic price shocks taking high values and suggesting that volatility spilled over from the world to the domestic rice market.

Figure 8.2: Mexican and world maize prices: domestic price conditional variance, world price conditional variance and conditional correlation

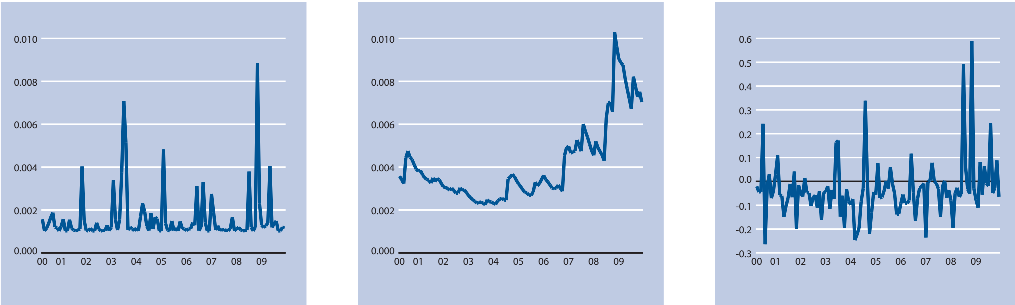


Figure 8.3: Indian and world rice prices: domestic price conditional variance, world price conditional variance and conditional correlation

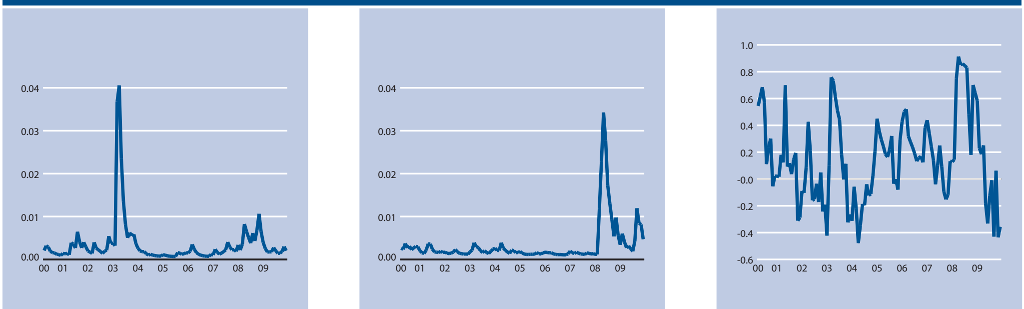
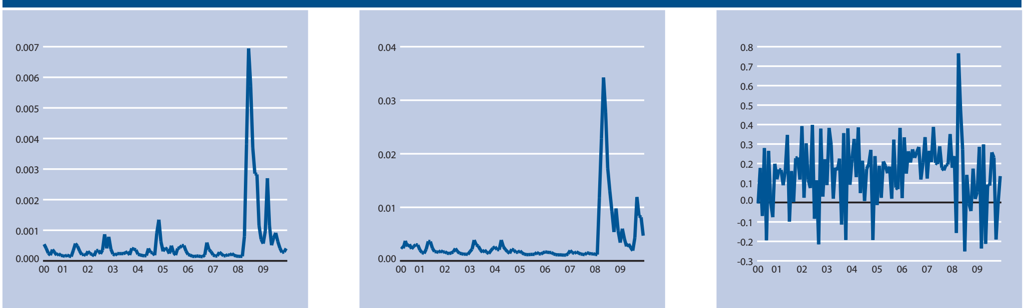


Figure 8.4: Philippine and world rice prices: domestic price conditional variance, world price conditional variance and conditional correlation



This is surprising for a country that manages the rice market through a parastatal marketing board mandated to stabilize prices. However, in recent years the country has imported rice in order to add to domestic supplies and to keep the price at a pre-determined level. On average, during the period 2006-08, the Philippines imported about 2 million tonnes, making the country the biggest importer of rice (Balisacan et al., 2010). In the first quarter of 2008, the government, facing low levels of public stocks, put out large tenders paying increasingly

Figure 8.5: Malawi and world maize prices: domestic price conditional variance, world price conditional variance and conditional correlation

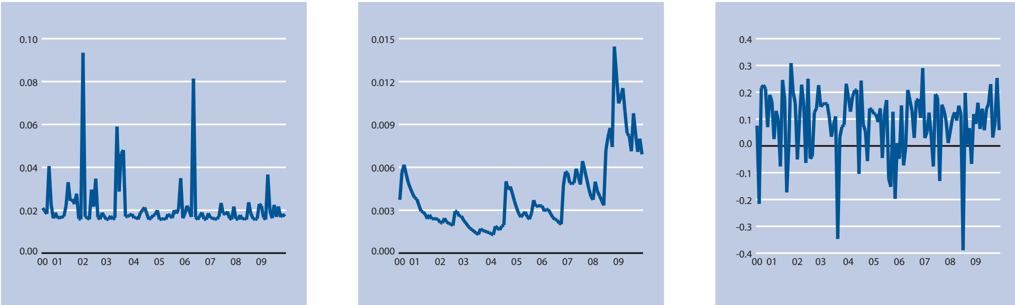
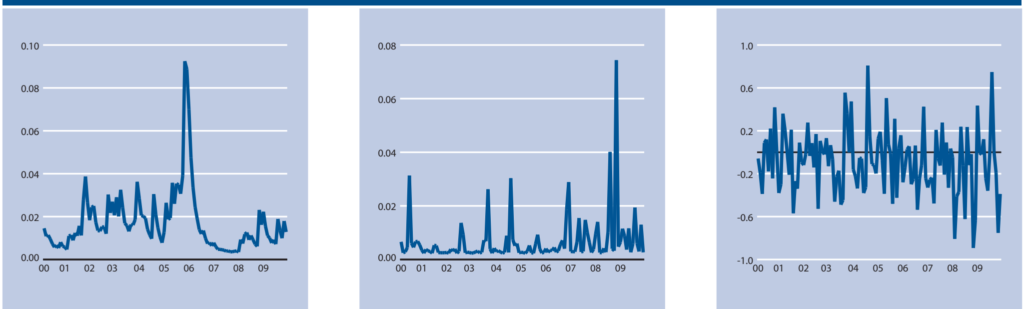


Figure 8.6: Niger and world sorghum prices: domestic price conditional variance, world price conditional variance and conditional correlation



high prices. Such strong buying behaviour contributed to the uncertainty in the markets, fuelling speculation in the Philippines as well as globally (Timmer & Dawe, 2010).

During the whole period 2000-09, maize prices in Malawi were extremely volatile (Figure 8.5). The country experienced episodes of extreme volatility associated with a price surge in 2002 caused by the failure to harvest sufficient staple maize owing to a drought. Similar increases in volatility took place in 2005-06. In 2002, adverse weather resulted in crop failures and food shortages, but the causes of the food crisis in Malawi were complex, also including errors in early warning systems, distortions in domestic markets, and mismanagement of food reserves. Such significant increases in the volatility of the price of maize are in line with the result of the previous section and the estimated VECMs. Slow adjustment to world market prices points out a partly insulated market with limited buffer capacity to contain domestic shocks over periods of relative market tranquillity. The bout of price volatility instigated by the 2008 price surge appears to be small, as compared with past extreme volatility values. This does not suggest that during international commodity price surges there is limited volatility, but highlights that domestic volatility is equally important.

The maize market in Malawi is characterized by a dual marketing structure where the government operates along the private sector through parastatal marketing boards and food security programmes intervening in the market. Both parastatals, the Agricultural Development and Marketing Corporation (ADMARC) and the Food Reserve Agency maintain a strong presence in the market. In addition to unfavourable climatic conditions, which generate wide shocks, discrete and largely unexpected policy responses increase domestic volatility. For example, during the food price surge of 2008, based on estimates of surplus production in May 2008, the government requested that the ADMARC accumulate stocks by initiating purchases in the domestic market. Within an environment of upward trending world maize prices, ADMARC progressively increased its price in order to outbid private traders and secure the requested quantities. Competition for maize between traders and the board was likely to have led to the domestic price increasing and remaining to high levels even after the world maize price decrease in the autumn of 2008 (Chirwa, 2009; Rapsomanikis, 2009). Poor transmission of price signals and unexpected policy responses have probably given rise to conditional correlations that change abruptly from positive to negative values. Again, irrespective of the signs, the conditional correlations are low, indicating that in general, volatility spillover from the world market may be limited, while the domestic maize price volatility remains extreme, persistent and, in general, determined by domestic shocks.

The case of sorghum in the Niger reveals the impact of both transaction costs and trade policies on domestic price volatility. The Niger is a less-developed landlocked country that regularly produces about 70 percent or more of the country's cereal needs and exports to neighbouring countries. Figure 8.6 presents the conditional variance and correlation for the price of sorghum in the Niger. The estimated variance suggests that from 2000 to 2006 the sorghum price in the Niger is characterized by high volatility. The extreme peak of the conditional variance during 2005-06 is associated with a domestic shock - an early end to the 2004 rains - which resulted in a food crisis and increased both price level and volatility. The conditional variance plot suggests that the 2008 international price surge had little effect on domestic price volatility. Although prices increased during this period, the Niger, together with other West African exporters of coarse grains, such as Burkina Faso, Mali and Nigeria, imposed export restrictions in an attempt to protect domestic consumers from the surging prices. Such policy response, though it resulted in keeping prices relatively low and less volatile as compared with the international price, increased the cost of food to the consumers of the region's traditional trading partners.

Policy implications and concluding thoughts

The effect of food price shocks on developing countries receives considerable attention whenever there are major international commodity price booms or slumps, such as the recent price surge in 2008. Our main empirical findings can be summarized as follows. Price volatility in the world and maize markets has been increasing since 2000. In most of developing countries examined, world price changes are partly transmitted to domestic markets. Although domestic markets are integrated with the world market in the long run, the adjustment of food prices in these countries to world market changes is slow. On average during the 2000-09 period, most of the food importing countries completed full adjustment to world price changes after a period of nine to ten months. This does not mean that international price surges are not transmitted to the domestic markets, but that the evolution of price upswings is different and timing of the price slump is delayed. Most markets examined exhibited sharp price increases during the end of 2008 and the first part of 2009. Often, in times of crisis, transmission is faster, as "bad news" affects the markets faster than "good news".

Panic and badly thought out policies often tend to accelerate the transmission of price spikes and exacerbate their impact on the domestic markets. Volatility spillover is also quite

Table 8.6: Domestic and international food prices: vector error correction models

	Peru - wheat		Mexico - maize		India - rice		Philippines – rice		Malawi - maize		Niger - sorghum	
	Δp_{dt}	Δp_{wt}	Δp_{dt}	Δp_{wt}	Δp_{dt}	Δp_{wt}	Δp_{dt}	Δp_{wt}	Δp_{dt}	Δp_{wt}	Δp_{dt}	Δp_{wt}
u_t	-0.406	-0.011	-0.117	0.133	-0.163	0.172	-0.212	0.079	-0.112	-0.008	-0.125	0.0134
	-5.588	*-0.289*	*-2.358*	*1.641*	*-2.574*	*2.547*	*-4.080*	*0.604*	*-3.359*	*-0.654*	*-3.514*	*0.627*
Δp_{dt-1}	-0.048	-0.006	-0.009	0.118	-0.032	0.033	0.378	0.282	0.520	-0.056	0.408	0.056
	-0.537	*-0.156*	*-0.093*	*0.764*	*-0.330*	*0.317*	*4.428*	*1.298*	*5.955*	*-1.563*	*4.858*	*1.112*
Δp_{dt-2}			0.179	-0.288	0.047	-0.0372	-0.069	-0.437	-0.060	0.089		
			1.824	*-1.895*	*0.489*	*-0.362*	*-0.850*	*-2.105*	*-0.676*	*2.443*		
Δp_{wt-1}	-0.131	0.216	0.0592	0.271	-0.149	0.576	0.044	0.595	0.575	0.247	0.043	0.149
	-0.605	*2.246*	*0.869*	*2.575*	*-1.712*	*6.195*	*1.124*	*5.953*	*2.539*	*2.655*	*0.275*	*1.610*
Δp_{wt-2}			0.083	0.076	-0.056	-0.114	0.082	-0.178	-0.663	0.009		
			1.286	*0.723*	*-0.611*	*-1.170*	*1.900*	*-1.630*	*-2.871*	*0.093*		
c	0.003	0.004	0.006	0.008	0.005	0.004	0.002	0.006	0.0030	0.003	0.005	0.004
	0.268	*0.710*	*0.501*	*0.442*	*1.174*	*0.928*	*1.113*	*1.100*	*0.217*	*0.551*	*0.448*	*0.584*

Note: The appropriate lag length was chosen on the basis of the Schwartz-Bayes information criterion.

limited during periods of world market tranquillity. None of the wheat and maize markets examined exhibit increasing price volatility, although this characteristic is evident in the world market. In general, domestic price volatility is persistent and mainly owing to domestic shocks, rather than world market shocks. Nevertheless, spillovers take place during extreme volatility episodes. All markets exhibited volatility clustering during the 2008 food price episode to a different extent, depending on the policies that were implemented at the time.

The analysis of the Indian rice market is of particular interest. India's power in the world market results in a bi-directional causal effect between domestic and world prices. Changes in the price of rice in one market will affect the other. The results suggest that volatility is characterized by the same relationship. Nevertheless, price stabilization policies in India, and more specifically the imposition of export restrictions during the recent price surge, dampened domestic market volatility while increasing volatility in the world market. Concerted implementation of export restrictions by major exporters renders the world market unreliable as a source of food (FAO, 2010). Government control over exports and imports and food reserve management to defend pre-determined prices characterizes the rice sectors of most Asian rice producing countries. During the 2008 price surge, bans in rice export triggered substantial instability in the market, especially because governments announced the export bans without clarifying their duration.

Completely banning food exports was also a common reaction to the food price surge across Africa, with many countries, including the Niger, a traditional exporter of sorghum and millet, closing their borders. Although export bans can generally lower domestic food prices and dampen volatility, there are also a number of negative consequences. First, export bans imply a tax on producers and lower the incentive to respond to the world price rise by increasing supply. In the long term, export restrictions may discourage investment in agriculture and thus can have negative implications for food security. Second, in the short term, export restrictions can harm traditional trading partners. For example, during the height of the food price surge in 2008, the National Cereals and Produce Board, the state marketing board of Kenya, was not able to import sufficient quantities of maize mainly owing to export bans implemented by a number of countries in the region. Finally, export bans, especially in Africa, add to the already high transaction costs and result in high welfare losses.

The analysis points out that a two-prong policy approach is necessary to reduce food price volatility in developing countries. First, in developing countries where markets are insulated (such as in Malawi), the focus should be on domestic policies leading to reductions in domestic volatility. Second, there is need for international community action to mitigate the negative effects of international price volatility on developing countries. Price volatility contributes significantly towards the vulnerability to poverty and inhibits development. It results in significant income risks that blunt the adoption of technologies necessary for agricultural production efficiency, as producers may decide to apply less productive technologies in exchange for greater stability.

Significant investment increases are needed to build better infrastructure and increase productivity. Poor infrastructure results in partial integration with the world market and increases the incidence of significant domestic price surges. It also results in markets failing to provide incentives to increase food production and engage in trade in the longer run. Low productivity inhibits the resilience of agriculture to international price shocks. Investments in infrastructure, extension services, education, as well as in research and development specific to small-scale agriculture can increase food supply in developing countries and improve the functioning of local agricultural markets and result in less volatile prices.

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Part II

WHY A NEW POLICY DIALOGUE IS NEEDED

Chapter 9

The world rice market in 2007-08[1]

David Dawe and Tom Slayton[2]

So far, the commodity focus of this volume has been on major grains and oilseeds, given their strong link to food security against the fact that global price determination and discovery are centred on commodity exchanges in developed countries. There is of course another staple food crop which plays a critical role for food security across the world.

Being produced on different types of land and in largely in different countries, and, in the main, being consumed by different groups of consumers, rice is somewhat disconnected with markets for other cereals. Empirical evidence shows that shocks to rice supply and demand are not significantly correlated with those to other grains. That the major global futures markets[3] are inconsequential to the world market for rice and that the crop does not constitute a commercial feedstock for bio-energy production also distinguishes the commodity from others. Finally, that only a fraction of global production is supplied on international markets also sets it apart from other major staples.

But this apparent uniqueness has not mattered in past crises and high price episodes. For instance, within the space of a growing season, reference rice prices trebled during the episode of 2006-08, and doubled in the 1973-74 crisis.

More importantly, and for illustrative purposes for the book, it showed how the lack of policy coordination among major producing and consuming countries, can instigate exceptional bouts of turmoil in markets.

Background

Between October 2007 and April 2008, a span of just six months, world market rice prices for Thai 100 %B tripled, from USD 335 per tonne to over USD 1000 per tonne, reaching the highest level ever recorded in nominal terms. Even during the world food crisis of 1973-7, world rice prices had never doubled within six months, much less tripled. More than any other event, this price surge brought tremendous media attention to the global price episode of 2007-08.

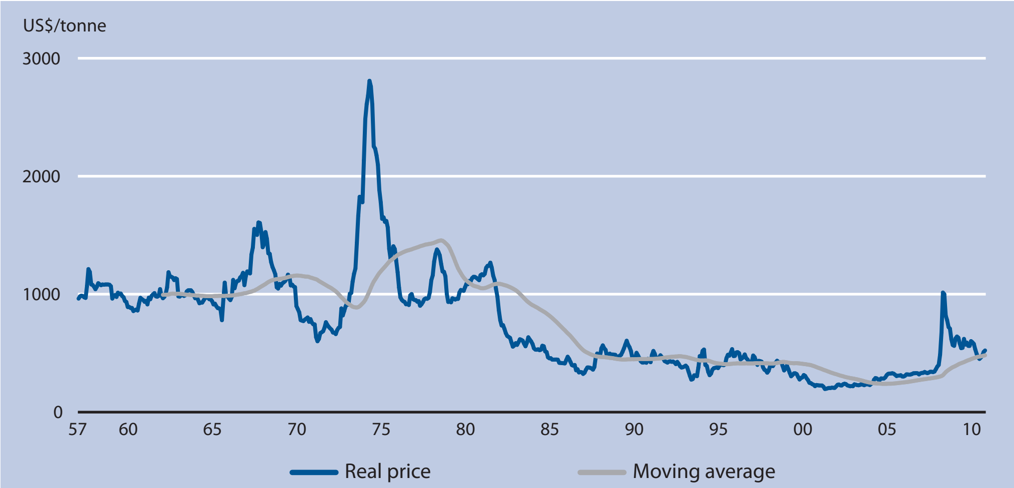
It is important to note that, after adjusting for inflation, peak prices in 2008 were well below the levels reached during the world food crisis in 1973-74. Indeed, in real terms, the

1 This chapter is based on Dawe & Slayton (2010).

2 David Dawe, Agricultural Development Economics Division (FAO); Tom Slayton, Founding Publisher and owner of the "Rice Trader", United States of America.

3 Note that futures markets exist in both Asia (e.g. Bangkok) and Chicago, but their influence on international markets and prices are minimal.

Figure 9.1: Monthly inflation-adjusted rice prices: January 2000 to September 2007



Source: FAO (2009a) for rice prices, IMF (2009) for United Stated consumer price index. Data refer to Thai 100 %B FOB.

average price in 2008 was not even half of the average price during those three years. Even more strikingly, the peak in 2008 (again in real terms) was *below* the price in 74 of the 82 years between 1900 and 1981![4] This shows how much real world rice prices have declined over the longer term.

While the historical perspective is interesting and important, the world rice market turmoil of 2007-08 led to substantial surges in domestic rice prices in many countries around the world (Dawe & Morales-Opazo, 2009), which in most countries led to substantial adverse impacts on the welfare of the poor (Ivanic & Martin, 2008; Zezza et al. 2008; Dawe et al., 2010). Because rice is the most important source of calories for the world's poor, the world rice market turbulence was probably the most serious shock to world food security in the previous 25 years. Thus, it is an event well worth explaining.

For the previous 20 years, the world rice market had been relatively stable (Dawe, 2002), and as late as September 2007 it seemed as though the world rice market would not be subject to the price surges seen on the world maize and wheat markets: world maize prices increased 54 percent from August 2006 to February 2007, followed by an increase in world wheat prices of 125 percent from May 2007 to March 2008. While world rice prices nearly doubled in nominal terms between the trough reached in April 2001 (USD 170 per tonne for Thai 100 %B) and September 2007 (USD 333 per tonne), the gain in real terms was just 67 percent, and, more important, the rise had been very steady and gradual, especially compared with later events (Figure 9.1).

Because the rise was gradual and from a very low starting point (the lowest real price since at least 1900), and because many Asian governments stabilize domestic prices, the price increase on world markets between 2001 and 2007 did not lead to substantial domestic price increases (Dawe, 2008a). But the world price increases that began in October 2007 were too

4 Seven of the eight exceptions were during the depth of the Great Depression and the three years immediately prior to the 1973-74 world food crisis.

large and too rapid for most countries to neutralize. The objective of this chapter is to describe and explain what happened to the world rice market during this time.

Rice market fundamentals were not the cause

The turmoil in the world rice market in 2007-08 was not caused by adverse shocks to rice production or low rice stocks. First, FAO estimates that world rice production increased from 635.2 million tons of paddy in 2005/06 (FAO, 2007) to 642.1 million tons in 2006/07 (FAO, 2009b), an increase of 1.1 percent. While not a large increase, it is similar to the rate of population growth in Asia, which is the main driver of demand as per capita rice consumption is declining in most countries and is generally stagnant in others.[5] In the subsequent two years, once world and domestic prices began to increase, world rice production increased by 2.9 and 4.1 percent, much greater than the rate of population growth.

Second, the world rice stock to use ratio was roughly constant in the three years preceding the turmoil (2004/05, 2005/06 and 2006/07) at 18 percent. It is true that the world rice stock to use ratio was much higher in earlier years (e.g. 37 percent in 2000/01), but this was almost exclusively owing to very high levels of stocks in Mainland China, which reached levels that exceeded annual use on several occasions in the late 1990s (i.e. a stock to use ratio of greater than 100 percent) before they were considerably reduced (Dawe, 2009).[6] China (Mainland) is often an important rice exporter, but it is difficult to argue that the decline in Mainland China's rice stocks from 1999/2000 to 2003/04 (several years before the high price event) caused the world rice market upheaval in 2007/08, especially as the decline in stocks did not lead to any major change in Mainland China's international trade flows.

In line with the favourable world rice production and stock situations noted above, it is also important to note that world rice trade increased during the turmoil. World rice trade in the first four months of 2008, when prices increased by more than 150 percent, was 20 percent higher than in the first four months of 2007 (Slayton & Timmer, 2008). Thus, there were ample supplies available on world markets. The favourable situation as regards production, stocks and trade strongly suggests that factors other than basic market fundamentals were at work.

Several factors external to the rice sector, however, arguably set the stage for turbulence in the rice market. Rising oil prices since 2004, a weak United States Dollar, and biofuels mandates and tariffs all contributed to rising maize and soybeans prices, and a 4.7 percent weather-induced decline in world wheat production from 2005/06 to 2006/07 led to a 67 percent increase in world wheat prices from May to September 2007. These price increases for petroleum, maize, soybeans and wheat created an atmosphere of concern and thus contributed to the policy decisions by key rice trading countries, both exporters and importers. It was these policy decisions that led to a substantially larger and more rapid price increase on the world rice market than on world maize and wheat markets, and the next section of this chapter will discuss these policy decisions in more detail.

5 It should be noted, however, that world and Asian rice production have been growing at rates slower than Asian population growth since 1990 (Dawe, 2008b). This is a serious medium to long term problem, but does not change the fact that sudden production shortfalls did not spark the world rice crisis. The slow long-term growth of yield (and production) relative to population was most likely responsible for the gradual climb in rice prices from 2001 to 2007.

6 The stock releases in Mainland China stabilized domestic consumption in the face of large declines in production for both rice (19 percent) and wheat (24 percent) between 1999 and 2003. The production declines were due primarily to large declines in area harvested in the face of increased labour scarcity.

Policies, uncertainty and "rational panic"

While[7] maize markets had to contend with biofuels policies and mandates (which added to demand), and wheat prices had to contend with bad weather (which reduced supply), there was no similar fundamental challenge that rice markets had to contend with (other than policies). Rice is also barely traded on futures markets, removing another factor that arguably influenced maize and wheat markets (Gilbert, 2009, Timmer 2009). Thus, policies and panic are the only plausible explanation for why rice prices increased so much more, and so much faster, than maize and wheat prices. The thin nature of the world rice market, and the large role that governments play in it, make the world rice market more vulnerable to such occurrences.

The atmosphere of uncertainty on world commodity markets noted above created incentives for policy-makers to secure additional supplies as soon as possible. While such an approach might be rational for an individual country, it serves to propel prices higher in a vicious circle if all countries implement similar policies. Such policy decisions also create further uncertainty within countries, and can easily cause individual producers, traders and consumers to also engage in hoarding. While the action of any one individual is irrelevant, Timmer (2009) shows that the cumulative effect when millions of households behave in this fashion can be quite substantial. Eventually market fundamentals took hold, and when they did, the "bubble" popped. In addition to this “rational panic,” the manner in which the demand was expressed (e.g. supplies were purchased at prices well above then-existing market prices) also contributed to the turmoil.

While many countries changed their trade policies during the episode, the focus here is on three countries that played especially important roles given their large roles in the world rice trade. In 2007, India and Viet Nam were the world’s second and third largest rice exporters and the Philippines was the world’s largest rice importer. While shipments from Thailand (the world’s largest exporter) played an essential role in preventing even greater price surges, several statements by its government officials unnerved the market.

India

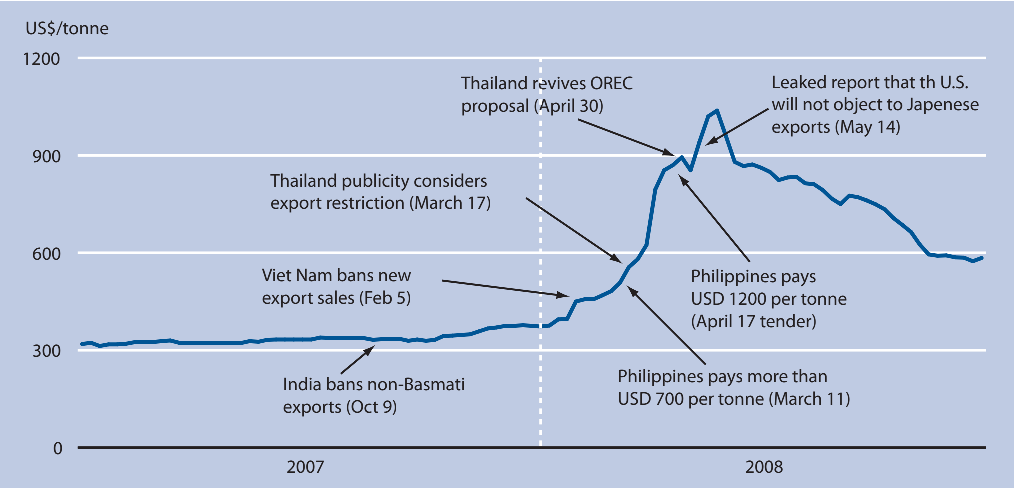
As noted above, the situation in the world rice market up until September 2007 was relatively stable, despite the volatility in other commodity markets. But, on 9 October 2007, India banned exports of non-Basmati rice (Figure 9.2). This was a key decision from a country that, from 2002 to 2006, supplied about 17 percent of the world market. This ban was replaced three weeks later with a series of ever-higher minimum export prices (MEP) that were set well above world price levels.[8] India then once again reverted to an outright ban on 1 April 2008. In the wake of these decisions to restrict exports by the world’s second largest exporter in 2007, the world market price for Thai 100 %B increased from USD 335 per tonne in October to USD 481 per tonne in February 2008, an increase of 43 percent in four months, before soaring further in March and April as additional policy decisions in other countries exacerbated the uncertainty (see below).

India’s decision to restrict rice exports had its roots in weather-related damage to its 2006 wheat crop and resulting wheat imports in 2006/07 (April-March) of 6.7 million tonnes, the

7 The discussion in this section draws heavily on Slayton (2009).

8 The first MEP on October 31 was set at USD 425 or USD 100 per tonne above prevailing Pakistani 25%, but in late December it was raised to USD 500 - USD 150 per tonne above FOB Karachi values. On March 9, 2008, the MEP was boosted to USD 650 or USD 190 over Pakistani 25% quotes.

Figure 9.2: Timeline of key events in the world rice market turbulence



Note: Price data are weekly, Thai 100 %B FOB (FAO, 2009a). Quoted Philippine prices are converted from Viet Nam 25% brokens C&F to Thai 100 %B FOB by using freight costs of USD 30 per tonne, financing costs of USD 10 per tonne, and the average quality differential between Thai 100 %B and Viet Nam 25% from March 2007 to February 2008 of USD 40 per tonne (the quality differential is calculated based on data in FAO 2009b). Event details are from Slayton (2009).

highest level in more than 30 years. Furthermore, world wheat prices were rising rapidly in mid-2007. Continuation of high levels of wheat imports was thus both expensive and politically problematic in the run-up to provincial and national elections.[9] As a result, India bartered rice for wheat by reducing both wheat imports and rice exports. This stabilized aggregate national cereal supplies and eliminated the need for wheat imports.

It should be noted that some exemptions to the ban/MEP were permitted, especially to Bangladesh. For example, India on 1 December 2007, agreed to supply Bangladesh with 500 000 tonnes under a Government-to-Government (G-to-G) contract and two months later agreed to a price of USD 399 C&F (the C&F price includes the cost of the rice plus the freight costs for shipment to the destination port). India, however, supplied only 100 000 tonnes at this price and eventually the balance was contracted at USD 430 C&F on 3 April 2008. The latter contracts provided for shipment within 60 days of the opening of the letters of credit, but the shipments were only completed in December 2008.

During the six-month period between October 2007 and March 2008, official statistics indicate over 2.5 million tonnes of non-Basmati were exported from India. Even after non-Basmati exports were once again banned on 1 April, shipments continued - above and beyond those exceptions allowed for the G-to-G sale to Bangladesh and sales agreed upon to Bhutan, Sri Lanka and others. From April to December, India exported 905 000 tonnes of non-Basmati, bringing calendar year 2008 movement to over 2.0 million tonnes, or 3.2 million tonnes below year-earlier shipments.

9 There were elections in several important states such as Madhya Pradesh, Rajasthan, Chhattisgarh and Delhi in late 2007 and the national election in 2008. Traditionally, food inflation plays a significant role in deciding the election outcome as high food prices impact the livelihood of *aam aadmi* (common man) who spend more than half of their income on food.

Although trade did not stop completely, the export restrictions created substantial uncertainty in the market, especially because the duration of the restrictions was not clear (the restrictions had still not been lifted as of November 2009). Informed observers generally expected a substantial shortfall in Indian exports.[10] There is little doubt that the uncertain nature of the restrictions, both in terms of the temporal duration and the magnitude of the expected export shortfall, made importers nervous.

Viet Nam

Rice production in Viet Nam is spread over three seasons, with the winter-spring crop being the largest and the one that recharges the country's exportable surplus. The Government regulates the quantity of rice exports, and, in a typical year, the export sales quota has been reached by late summer. A new quota is then not issued until the eve of the harvest of the winter-spring crop in the Mekong River Delta (MRD), which typically begins in late February. At this point in time, it is relatively clear how large the winter-spring harvest will be, and thus easier to set an export quota while still ensuring that domestic supplies will be adequate. Between late summer and late February, the execution of previously approved contracts is allowed, but new sales are not.

In 2007, the export sales quota was reached by 21 July and no further supplements to the quota were issued. Thus, while there was an export sales ban in place in Viet Nam before that in India, this ban was anticipated and did not substantially disrupt the international rice trade nor create added uncertainty.

The situation changed in early 2008, however. New export sales were once again allowed from mid-January, but they were only allowed for two and a half weeks before the Government banned new sales owing to fears over unseasonably cold weather in the Red River Delta. Initially, it was not clear how long the prohibition was to last. Traders were eventually advised that the ban would be lifted by the end of April, but this was subsequently extended through June, and then was only lifted after a large G-to-G sale was negotiated with the Philippines. These actions added to uncertainty in the market.

Negotiations between Viet Nam and the Philippines

Despite the ostensible ban on new sales, Vinafood 2 (a state-owned exporter) and selected provincial food exporters were permitted to participate in the National Food Authority (NFA)'s December 2007 and January 2008 tenders for imported rice. (The NFA is the state-owned rice importer in the Philippines). These tenders resulted in contracts for over 700 000 tonnes, of which about 620 000 tonnes were scheduled for first quarter arrival in the Philippines. The level of arrivals scheduled for the first quarter was higher than could be delivered given limited carryover stocks in Viet Nam and the fact that the winter-spring harvest in the MRD does not begin until late February, making it difficult to ship such large volumes to Manila before the end of March. In the event, only about 320 000 tonnes were actually delivered during the first quarter. Furthermore, the price paid in the January tender was about USD 70 per tonne higher than that paid in the December tender, despite much smaller increases in both local Vietnamese and Thai export prices during that time.

In March and April, the Philippines continued to put out more large tenders. More important, however, it agreed to pay the increasingly high prices being quoted by Viet Nam,

[10] USDA initially forecast a 1.8 million tonne decline in exports (USDA, 2007), but revised this to a decline of 3.5 million tonnes as the magnitude of India's 2008 export volume became apparent (USDA, 2008a).

even though they were above market levels.[11] While government stocks were low in the Philippines, private stocks (which constitute the bulk of total stocks) were estimated to be ample, and official forecasts were for a record dry season crop. The eventual outcome for the 2008 dry season crop (which is harvested January to June, with the bulk occurring in March and April), was an increase of 5.8 percent over the previous record set in 2007. Domestic prices did increase from January to February, but the increase was in line with what would be expected based on normal seasonal patterns. Thus, there were no signs of upheaval in the Philippines when the 11 March tender was signed, although prices did soar soon afterwards.

Despite the solid market fundamentals in the Philippines, it agreed at the 11 March tender to buy 25% brokens at a price of USD 716 C&F, almost 50 percent above the previous sales price, far above prevailing prices in the MRD and USD 150 per tonne above prices in the spot market. Then, nine days before the 17 April tender, NFA announced that there would be another large tender in early May. This announcement contributed to higher prices and lower quantities offered at the April tender, when NFA bought about 365 000 tonnes, including 80 000 tonnes of Viet 25% at an average C&F price of USD 1 200 per tonne, USD 484 higher than the sales price of just one month earlier and again higher than the spot market.

These tenders fuelled speculation and higher prices in both the MRD and in the Philippines, as well as globally. When news of the April sales circulated within the MRD, local traders - including those involved in trading other commodities - jumped into the market as buyers and within a week there was a run on rice in Ho Chi Minh City (HCMC). Within the course of a two-day period, local prices doubled as rice disappeared from the markets within the city (prices subsequently fell quickly from these peaks). Monthly national average wholesale rice prices increased in the Philippines by 7 percent in March, another 18 percent in April and by a further 19 percent from April to July.

During this time, the Philippines made repeated efforts to commercially tender for United States of America rice, even though the delivered prices would be very high given the usual premium for rice from the United States of America and the higher freight rates entailed by the longer shipping distance. The President of the United States of America also publicly pursued a Memorandum of Understanding (MOU) with Thailand for more rice deliveries. These actions, coupled with the acceptance of the high Vietnamese prices offered at the tenders, conveyed the impression that the Philippines would be willing to pay almost any price for rice imports. This very inelastic demand is difficult to reconcile with the large dry season harvest, which has accounted for 42 percent of the annual harvest in recent years. Furthermore, it is not clear why the tenders were so large, or why a subsequent tender in May required a sovereign guarantee. Both of these conditions made it more difficult to procure rice at competitive prices from a wide array of traders.[12]

Thailand

While a number of countries restricted exports during the high price episode, Thailand, in the end, never did. For six consecutive months beginning with October 2007, monthly Thai exports topped 1.0 million tonnes and during the subsequent four months shipments averaged 914 000 tonnes. Indeed, over the 12 months ending in September 2008, Thailand exported more than 11.7 million tonnes.[13] Without these exports, it is hard to imagine how high world prices would have gone.

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11 This same practice of paying above market levels continued into 2009 (Reuters, 2009).

12 Viet Nam's policy of limiting domestic participation in the NFA tenders also helped to propel world prices higher.

13 This was 3.1 million tonnes above the export levels averaged during 2002-06.

Nevertheless, Thai policies and statements also contributed to the uncertainty in the world market. In February 2008, the head of the Ministry of Commerce's Public Warehouse Organization called for the newly elected government to auction off half a million tonnes of its 2.1 million tonnes of stocks. Thai exporters were in favour of this proposal, but the Government kept almost all of its stocks off the market. In mid-March, the Vice-Minister of Commerce was quoted as saying that the Government was considering imposition of export restrictions for the first time in more than a generation. Then, on 28 March, the Minister urged farmers not to sell as he predicted prices would reach USD 1 000 per tonne by June (he did not specify whether he was referring to prices of Jasmine rice or 100 %B). Thailand later insisted that it would not restrict exports and, indeed, it did not, but the threat of such action added to market uncertainty.

In late April, the Thai Government resurrected a proposal that Thailand, Viet Nam, Cambodia and Myanmar create a rice exporter cartel, the Organization of Rice Exporting Countries (OREC). Not surprisingly, this proposal heightened market fears, and the Philippines and international organizations like the Asian Development Bank came out against the proposal. The cartel plan was endorsed by Cambodia's prime minister, but world public opinion forced Thailand to withdraw the proposal on 6 May - just one week after it had been unveiled (USDA, 2008b).

Government stockpiling, more export restrictions, the media and international organizations

In addition to efforts by the Philippines to stockpile rice, other countries made similar moves. Malaysia, for example, announced plans in mid-January 2008 to increase Bernas' stock levels six-fold from two weeks (92 000 tonnes) to three months (550 000 tonnes).[14] Nigeria announced plans to increase imports by an extra 500 000 tonnes and build up its strategic reserve by the end of 2008. While these plans failed to materialize after world prices reversed direction, the statements of intent contributed to sending prices higher.

Exporters other than India, Viet Nam and Thailand also contributed to market uncertainty. Egypt suspended exports in mid-January, and the ban remained in place for almost a month, although it was then replaced with an export tax of more than USD 50 per tonne. By the end of March, a ban was back in place, due to expire in October. In early June, however, the ban was extended to April 2009. China (Mainland) delayed issuance of export quotas during the turbulence, and shipped out only 56 000 tonnes at the peak of the market during April-June 2008, down from 170 000 tonnes during the same period one year earlier, despite holding substantial stocks.[15] And Cambodia also temporarily banned exports, although this ban was not as strict or effective as many thought (see next paragraph).

The media also played a role through superficial reporting of some of the export restrictions. For example, Cambodia's decision in late March 2008 to ban exports was given more play in the popular press than was warranted given its actual impact. Not only was the ban temporary (two months), but it was also soon largely lifted. About two-thirds of Cambodia's exports are made via Viet Nam, and the ban on shipments by the three eastern-most provinces was lifted within two weeks of the original announcement. Further, Cambodia is a very minor exporter (USDA, 2009) estimates its annual exports averaged about 330 000

[14] Bernas is Malaysia's sole rice importer.

[15] Mainland China's annual export quotas for rice are typically only decided by the National Development & Reform Commission about one month after the end of the lunar New Year celebrations. As of late April 2008, however, a senior official was quoted as saying export quotas for 2008/09 still had not been issued.

tonnes from 2004/05 to 2006/07) and movement out of the country probably had largely occurred before the ban was announced - most of Cambodia's shipments occur around the beginning of the calendar year immediately after its main crop is harvested. Finally, the Cambodian-Vietnamese border is very porous and enforcement of the edict was likely difficult.

Similarly, at the peak of the turmoil in late April it was reported that Brazil - also a minor exporter USDA (2009) reports its exports over the preceding three years as averaging just over 250 000 tonnes) - had banned all rice exports. Within a few days, it was clarified that this only involved government-held stocks, but most buyers likely did not hear of this distinction.

Finally, statements by key officials of well known international organizations forecast higher prices. While understandable on one level given the declining funds devoted to agricultural development during the past twenty years, such statements are viewed by many as authoritative and contribute to market jitters.

In sum, a series of government actions in India, Viet Nam, the Philippines, Thailand and other countries created substantial uncertainty in the world rice market.[16] These policy decisions collectively created a speculative bubble that encouraged farmers, traders and consumers to hoard rice, further increasing prices.[17]

The "bubble" pops

The first two weeks of May brought two natural disasters, as Cyclone Nargis struck Myanmar's Irrawaddy Delta on 3 May and a strong earthquake jolted Sichuan province in Mainland China on 12 May. Initial estimates of losses owing to Cyclone Nargis were placed at 2 million tonnes of paddy, although these estimates eventually proved to be too high.

But, around the same time, the Philippines aborted its 5 May tender as there was only one bidder (Vinafood 2; at least two bids are legally required in order to execute a purchase), and that one did not meet the sovereign guarantee requirement that the Philippines imposed. Four days later, the Philippines publicly disclosed that it was negotiating with Japan for 60 000 tonnes of its domestic rice. That same day, the Center for Global Development (CGD) released a paper arguing that world rice prices could be reduced drastically and quickly if the United States of America would allow Japan to export some or all of its 1.5 million tonnes of imported rice (Slayton & Timmer, 2008). The paper also pointed out that Thailand and Mainland China had large stocks available for export.

United States of America Congressional Committee hearings on the food market turmoil were held 14 May, and that evening Bloomberg news quoted an unnamed United States of America trade official that the country would not object if Japan were to release its stocks. That week, rice futures prices in the United States of America fell for four straight days, and rice futures prices in Thailand began a 29 percent decline from 13 May to 3 June. The Philippines

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[16] Other government actions fuelled speculation in domestic markets, but those actions are not discussed in this chapter, which focuses on the world market. For more details, see Slayton (2009).

[17] It might be objected that the data on stocks do not show a large increase during this time. However, FAO and USDA, the two main sources of stock data, only maintain data on an annual basis. Furthermore, the quality of the data is acknowledged to be low given the difficulties of convincing market participants to provide accurate information, and this difficulty would be amplified in a crisis situation where some governments threatened severe penalties (e.g. life imprisonment) for hoarding or speculation. The volume of stocks held by billions of small consumers across Asia is another large source of uncertainty).

announced on 19 May that Japan might provide it with 250 000 tonnes, including 200 000 tonnes of imported rice. On 21 May, major Thai exporting companies began to once again provide daily price quotations, a longstanding practice they had suspended in February. At a high level conference at FAO on 2 June, Japan pledged to export over 300 000 tonnes of imported rice. In the event, Japan never did export the rice that it pledged; indeed, rice exports in 2008 were only 117 000 tonnes, less than in 2007. But the mere prospect of this additional rice being released onto world markets seemed to have been sufficient to reverse the upward momentum of prices. According to weekly (FAO, 2009a) data, Thai 100 %B rice prices peaked in the second half of May at more than USD 1 000 per tonne FOB and slid downward from there. The decline in rice prices thus occurred even though crude oil prices were still rising (they did not peak until early July).

NFA then concluded a Government-to-Government deal with Viet Nam for 600 000 tonnes in mid-June, and signalled that it had met its import demands for the year, and a few days later Viet Nam lifted its export ban. Thailand had also indicated that it was considering unloading some of its stocks. These events helped reverse the dominant bullish market psychology that held sway just several weeks earlier.

This downward momentum was eventually sustained by larger macroeconomic forces and the financial and economic crisis. Freight rates, as measured by the Baltic Dry Index, began a sharp decline that saw rates decline 94 percent from early June to the end of the year. World oil prices peaked at a monthly average of USD 133 per barrel of West Texas Intermediate in July, and urea prices peaked in August. For the remainder of the year, cereal prices declined substantially. By December, average monthly prices for rice, wheat and maize had all declined by 45 to 50 percent from their peaks earlier in the year.

Conclusions

While free markets do not always deliver optimal price stability, turmoil in the world rice market during 2007-08 was not owing to a failure of free markets: government policy decisions were decisive in sparking and fuelling turmoil. The world rice market is particularly vulnerable in this regard because it is relatively thinly traded[18] and because of the large role played by governments in the international trade that does take place.

Government interventions by many countries, including major exporters and importers, created uncertainty and encouraged hoarding and panic on the part of other governments, farmers, traders and consumers. The role of state-owned enterprises was particularly problematic during the event owing to their lack of transparency in conducting trade. While the private sector is not transparent either, its activities are constrained by competitive forces, which is not true for governments.

The world market price turbulence eventually led to domestic price surges in a number of countries. The increases in domestic prices caused severe hardship for many poor consumers, who in most of these countries dominate the lowest parts of the income distribution. These consequences underline the need to improve the functioning of the world rice market in times of extreme volatility and crisis.

While governments will most likely continue to play an important role in this market, this role needs to be more transparent and predictable, and should be tempered by a much greater role for the private sector. Such relatively simple changes would most likely have

[18] During the period 2000-2007, world exports constituted 7, 13, and 20 percent of production for rice, maize and wheat, respectively.

been sufficient to avoid the turmoil that occurred, even in the absence of other measures that have been discussed (e.g. regional stocks, larger national stocks, virtual reserves).

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Chapter 10

Country responses to turmoil in global food markets: The nature and preliminary implications of the policies pursued in the 2006-08 episode[1]

Mulat Demeke, Guendalina Pangrazio and Materne Maetz[2]

The downward trend in real food prices for the past 25 years came to an abrupt end when world prices began rising in 2006 and escalated into a surge of price inflation in 2007 and 2008. Prices of staple foods such as rice and vegetable oil doubled between January and May 2008. The upturn coincided with record petroleum and fertilizer prices. For low-income and highly import-dependent countries, higher food prices and larger import bills have become a major challenge, particularly for those with limited foreign exchange availability and high vulnerability to food insecurity (Rosen & Shapouri, 2008).

High food prices, in combination with high and volatile petroleum prices, have the potential of spurring inflationary pressures, competing for public expenditures intended for alleviating poverty or meeting Millennium Development Goal (MDG) targets and fuelling political unrest. Poorer households with a larger share of food in their total expenditures are suffering the most from high food prices, owing to the erosion of purchasing power, which has a negative impact on food security, nutrition and access to school and health services.

Policies responding to rising food prices have included a series of short-term, immediate measures. These can be grouped into three main areas:

- Trade-oriented policy responses that use policy instruments such as reducing tariffs and restricting exports to reduce prices and/or increase domestic supply;
- Consumer-oriented policy responses that provide direct support to consumers and vulnerable groups in the form of food subsidies, social safety nets, tax reductions and price controls; and
- Producer-oriented policy responses intended to support farmers to increase production, using measures such as input subsidies and producer price supports.

The objective of this chapter is to examine the short-term measures that were adopted by some 81 countries in Asia, Africa and Latin America and the Caribbean (LAC) during the 2006-08 episode and to assess their implications for food security and poverty alleviation. The analysis is based on data from weekly reports filed by FAO Representatives in Member countries, assessment reports conducted by the FAO in collaboration with other agencies

1 This chapter is based on FAO (2009).
2 Agricultural Policy Support Service (FAO).

such as the World Food Programme (WFP), World Bank and the International Fund for Agricultural Development (IFAD), reviews and notes prepared by national or international agencies, as well as press reports.

Market and trade policy measures to reduce prices for consumers

Based on information obtained from 81 countries, the two most widely applied market and trade policy measures were reducing tariffs or custom fees, as reported by 43 countries, and selling grain from public stocks or from imports, as reported by 35 countries (see Table 10.2). Reducing tariffs was among the easiest measures to implement. Countries with reserve stocks have been able to respond more quickly and cheaply than those with limited or no reserves. Some 23 countries suspended or reduced value-added tax (VAT) and other taxes, while 25 countries restricted or banned exports. Price controls were reported in 21 countries, with ten of these in Africa. A number of countries applied two, three or even four different market and trade measures to bring down domestic prices. The manner in which the different market and trade measures were applied varied from country to country, as discussed below.

Releasing food stocks to the market

Releasing public stocks and providing consumer subsidies were among the most common measures applied to contain the problem of rising food prices. Countries such as India, Ethiopia, Senegal, Cameroon, China (Mainland) and Pakistan released public stocks and offered targeted and untargeted subsidies for staple food. However, the degree to which prices were influenced on the open market depended on the amount of food stock released or made available for release onto that market.

National grain reserve systems and state grain trading companies, together with bumper harvests, helped China (Mainland) escape the steep increases in grain prices that hit other countries in the Asia-Pacific region. A record purchase of rice and wheat by the Food Corporation of India[3] (the Government's grain procurement and distribution agency) in 2008 created an opportunity for the Indian Government to release sufficient stock onto the market to stabilize prices. Owing to a good harvest, Malawi avoided cereal imports and even managed to export maize in 2008. Malawi has also a grain marketing parastatal that undertakes open market operations.

Some countries expanded imports to secure more stock and stabilize food prices. For instance, the Government of the Philippines, a middle-income country and the world's largest rice importer, increased its imports for 2008 to 2.4 million tonnes from 2.1 million in the previous year in a bid to ensure at least a 30-day stockpile until the end of the year.[4] The Saudi Arabian Government, one of the major importers of rice in the Middle East, proposed that rice importers consider raising their stocks of grain by 50 percent in 2008, which implied increasing strategic stock levels to cover between six and eight months of national consumption requirements (up from about four to five months' needs.[5] Japan and China (Mainland) were also reported to be holding very large stocks in excess of 18-20 percent of total consumption.

3 A 38 percent surge (over the last year) in the Food Corporation of India (FCI) grain procurement - amounting to 50 million tonnes - was anticipated in 2008 (Modi., A, "FCI procurement of rice, wheat touches 50 MT", Business Standard, New Delhi, 10 September 2008).

4 Philippine Daily Inquirer, "Government's hikes rice import quota to 2.4 million tonnes", 22 June, 2008.

5 Gulfnews, "Riyadh asks traders to raise rice stocks", Gulfnews.com, 29 July, 2008.

Many poor food-deficit countries seemed to have imported much less than they actually needed (owing to a shortage of foreign exchange) and appealed for food aid or external support to bridge the balance. The Government of Mauritania, for instance, allocated a USD 3.2 million budget (equivalent to 4 500 tonnes) for the replenishment of its National Food Strategic Reserve (NFSR) in 2008, while WFP (Mauritania) looked for funds to finance 6 400 tonnes for its life-saving activities. The Government of Burkina Faso implemented subsidized sales of grain and hoped that resources would be made available to WFP to assist 600 000 beneficiaries (through school feeding and mother and child health centres) in 2008.[6]

The Ethiopian Government sold about 190 000 tonnes of wheat from its grain reserve to about 800 000 urban poor and imported 150 000 tonnes of wheat in August/September 2008 to meet demand in urban areas, while WFP and NGOs channelled about 197 629 tonnes of food[7] to the increasing number of people requiring food assistance.[8] Poor harvests, limited public stocks and a shortage of foreign exchange posed a major challenge to food security in many poor countries. Over the years, several African countries had scaled down or scrapped their grain reserve programmes as a result of liberalization and market reform measures.

Reducing tariffs and VAT

A number of countries, including Bangladesh, Egypt, India, Indonesia, Mali, Mexico, Morocco, Pakistan, Peru, the Philippines, Senegal and Turkey, reduced or eliminated food tariffs or taxes. The impact of tariff reduction on food prices depends on the extent of the reduction, but tariffs in developing countries had been declining as a result of multilateral agreements, regional and bilateral trade pacts as well as from structural adjustment programmes (UNCTAD, 2008). While the decline in food prices as a result of tariff reduction had not been significant in many countries, the impact was substantial in several selected food items. For instance, Morocco cut tariffs on wheat imports from 130 to 2.5 percent, while Nigeria slashed duties on rice imports from 100 to 2.7 percent (ICTD, 2008). India removed a 36 percent import tariff on wheat flour and Indonesia eliminated duties on wheat and soybeans. Turkey cut import taxes on wheat to 8 percent from 130 and on barley to zero from 100 percent. Burkina Faso suspended import taxes on four food staples in February 2008 after riots over price increases.[9]

Several countries also suspended or reduced domestic taxes on food items. Brazil reduced taxes on wheat, wheat flour and bread.[10] Mongolia scrapped its VAT on (imported) wheat and flour.[11] The Republic of Congo reduced VAT levied on a range of basic imported foodstuffs and other goods from 18 to 5 percent in May 2008 (FAO Policy Database). In Madagascar, VAT was reduced on rice (from 20 to 5 percent), lighting/cooking fuel and possibly other primary necessity goods (FAO, 2008b). Kenya removed VAT (16 percent) on rice and bread (FAO Policy Database), while Ethiopia removed VAT and turnover taxes (15 percent) on food grains and flour (IMF, 2008a). These measures may have softened the price shocks but did not solve the problem.

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6 ReliefWeb, Rising food prices: Impact on the hungry, 14 March, 2008 <http://www.reliefweb.int/rw/rwb.nsf/db900SID/ASAZ-7DLBNQ?OpenDocument>.

7 OCHA Ethiopia, Weekly Situation Report, Drought/Food Crisis in Ethiopia, 23 September, 2008.

8 The government announced a revised estimate of people in need of humanitarian assistance from 4.6 million to 6.4 million. The revision necessitated additional resources.

9 Business Day, "Food prices trump trade talks", 14 April, 2008 <http://business.theage.com.au/business/food-prices-trump-trade-talks-20080414-25z7.html>.

10 Reuters (2008a), Brazil cuts wheat sector taxes to ease inflation, 15 May, 2008 <http://uk.reuters.com/article/marketsNewsUS/idUKN1454178820080515>.

11 Business Day, "Food prices trump trade talks", 14 April, 2008 <http://business.theage.com.au/business/food-prices-trump-trade-talks-20080414-25z7.html>.

Controlling prices

Some countries attempted to control prices and restrict private grain trade in order to keep prices low for consumers. Sri Lanka announced retail and wholesale prices of all varieties of rice (effective 16 April 2008): the Government fixed maximum retail and wholesale prices for different grades of rice.[12] Senegal released assorted grains to the market and announced price controls (FAO Policy Database). The Government of Malawi announced that all maize would be sold through the Agricultural Development and Marketing Corporation (ADMARC) and fixed the price at which ADMARC would buy and sell maize.[13] The Government of Côte d'Ivoire announced emergency measures to cut prices of food and basic services in April following protests against the rising cost of living.[14] Malaysia imposed ceiling prices on rice sold to consumers and raised the guaranteed minimum price for rice growers.[15] Some governments, including India, Pakistan, the Philippines (Box 10.1) and Thailand, also enacted harsh penalties for hoarding grain.

Box 10.1: Anti-hoarding measures

The Philippines introduced an aggressive policy towards suspected price distortions: it created an Anti-Rice-Hoarding Task Force (ARTF) to seek out hoarders and punish them with life sentences for "economic sabotage" or "plunder" (IFDC, 2008). The ARTF handled proceedings on inquest, preliminary investigation and prosecution of all cases relating to unlawful acts or omissions inimical to the preservation and protection of the country's rice supply. Among the alleged violations were overpricing, unreasonable depletion of stocks, non-display and refusal to sell stocks to consumers.

The Ecuadorian Government set up a system of controls and monitoring of prices. Police checks were established in markets, supermarkets, district storehouses and shops. A campaign on enforcing the sanctions foreseen by consumer law was initiated: a fine of USD 100 to USD 1 000 and imprisonment for 6-24 months.

Enforcing price controls was costly and difficult in instances where there was no adequate public stock or imported supply to meet demand at government-fixed prices. Prices fixed at low levels were also likely to discourage domestic production and create a black market. Some governments thus opted for a partnership with the private sector to prevent price hikes. The Mexican Government, for instance, opted for public-private partnerships and announced a price freeze on 150 basic-basket food products until the year's end as part of a pact with the National Confederation of Chambers of Industry (Concamin). Food processors affiliated with the largest Mexican industrial trade groups agreed not to pass their rising production cost on to consumers. The agreement was intended to enable the Government to achieve price controls without direct economic intervention, such as through subsidies or ordering sanctions against manufacturers.[16]

The Government of Burkina Faso also negotiated with importers and wholesalers and announced indicative prices for some basic staple foods such as sugar, oil and rice. As a result

[12] Asian Tribune, "Sri Lanka imposes price control on retail and wholesale prices of rice", 17 April, 2008 <http://www.asiantribune.com/?q=node/10614>.

[13] IRIN, "Malawi: Cheer and concern over ban on private sale of maize", 28 August, 2008 <http://www.irinnews.org/Report.aspx?ReportId=80052>.

[14] IRIN, "Ivory Coast: Government curbs prices after second day of confrontations", April 4, 2008 <http://www.irinnews.org/Report.aspx?ReportId=77558>.

[15] China View, "Malaysia takes measures to keep price of rice down", 13 May, 2008 <http://news.xinhuanet.com/english/2008-05/13/content_8158823.ase>.

[16] Los Angeles Times, "Mexico is freezing prices on scores of food staples", 19 June, 2008.

of an agreement between the government and the private sector, prices of rice and sugar in Jordan were printed on all packages to avoid retail mark-ups. The Jordanian Government also launched a consumer awareness campaign and began publishing price lists of selected basic commodities (UNRC, 2008). Such measures, while popular with the public, were likely to reduce private storage or marketing activities and reduce incentives for producers. It was also unclear how long the private sector could continue to avoid passing rising production costs onto consumers. The experience of Pakistan is presented in Box 10.2.

Box 10.2: Administrative measures to control prices in Pakistan

To keep prices low during the procurement period (April-June) and to avoid wheat hoarding and smuggling, the Provincial Government of Punjab implemented administrative measures limiting the flow of wheat to other provinces. The measures included: i) enforcement of regulatory mechanisms to limit the inter-district and inter-provincial movement of wheat; ii) restriction on flour mills to stock wheat in excess of the one month requirement; and iii) provision of wheat flour rather than wheat grain to other provinces and to Afghanistan.

Source: High food prices in Pakistan, UN Inter-Agency Assessment Mission, July 2008.

Restricting exports

Major cereal exporters imposed restrictions in the wake of food price inflation. Argentina, Cambodia, China (Mainland), Egypt, India, Kazakhstan, Pakistan, Russian Federation, Ukraine and Viet Nam restricted food exports in an attempt to shore up domestic supplies. Unfortunately, world prices escalated as a result of the restrictions. The impact on the thinly traded rice market was particularly dramatic (see Figure 9.2 in Chapter 9). It was also claimed that export bans or restrictions created serious beggar-thy-neighbour effects owing to price volatility and shortages, particularly when they were applied by major exporters (World Bank, 2008a).

Although high grain prices brought more foreign exchange to exporters, reconciling export earnings with high food prices at home became a major policy dilemma. Argentina, one of the major exporters of food in the world, was faced with the difficult task of protecting its citizens from high prices without affecting its earnings from food exports. In March 2008, the Government announced the third tax hike in six months on exports of soybeans and other products as part of an overall strategy that aimed to keep local prices low and generate revenue that would allow the Government to redistribute the agricultural sector's disproportionate wealth to the people most vulnerable to price hikes. The Government was worried because food inflation had begun to affect the population. But farmers considered the government measure as stifling and their long and protracted protest resulted in the lifting of the tax in July.[17]

Egypt, India, Pakistan and Viet Nam imposed a ban or steeply-hiked minimum prices for fear of dwindling supplies and rising prices, but later lifted or promised to end their export restrictions.

Safety net measures

As shown in Table 10.3, 23 countries reported cash transfers, 19 implemented food assistance programmes and 16 reported measures aimed at increasing disposable income. Safety net

[17] Washington Post, "Argentina Tries to Reconcile Exporting Food With Prices at Home", 26 April, 2008.

measures were relatively less common than market and trade interventions. Mobilizing the necessary cash or food was not easy for poorer countries.

Cash and food transfers

Social safety nets were intended to lessen the social impact of the price turmoil and to avert starvation and malnutrition of the most vulnerable groups in both urban and rural areas. The two main categories of safety nets were targeted cash-based transfers and food access-based approaches.

Countries that used cash transfer programmes included Bangladesh, Brazil, China (Mainland), Costa Rica, Egypt, Ethiopia, Haiti, India, Indonesia, Mexico, the Republic of Mozambique and South Africa. A number of these countries – such as Brazil, Ecuador, El Salvador and Mexico – already had ongoing cash transfer programmes and they only scaled up the level of payment (to compensate for the high prices) or expanded the programme's coverage. Conditional cash transfers (CCT, payment made upon meeting requirements such as attending training, sending children to school, etc.) sought to create incentives for individuals to invest in human resource development. CCTs have been shown to reduce income inequality in Brazil, Chile and Mexico (Soares et al., 2007). Where CCT programmes already existed, increasing their benefit or coverage was a key part of the response. Establishing new CCTs, however, required capacity and took too long to constitute a rapid response during the high price event. They also carry the risk of being poorly targeted because they exclude the neediest.

Food assistance programmes included direct food transfer, food stamps or vouchers and school feeding. Countries such as Bangladesh, Cambodia, Ethiopia, Haiti, India, Liberia, Madagascar and Peru implemented self-targeted food-for-work programmes, while Afghanistan[18], Angola (World Bank, 2008d), Bangladesh and Cambodia (FAO Policy Database) distributed emergency food aid. School feeding programmes were reported by Brazil, Burkina Faso, Cape Verde, China (Mainland), Honduras, Kenya, Mexico and the Republic of Mozambique, among others (World Bank, 2008d). Countries such as the Dominican Republic, Egypt, Ethiopia, Indonesia, Jordan, Lebanon, Mongolia, Morocco, the Philippines and Saudi Arabia (FAO Policy Database) sold food at subsidized prices to targeted groups.

School feeding became an important component of food assistance and income support. It was increasingly viewed as a way to encourage students of poor households to maintain schooling and to discourage parents from placing them on the labour market. High food prices, however, resulted in dropping-out and reduced enrolments in the Philippines[19] despite the Government launching the "Enhanced" Food for School Feeding Program (SFP) in July 2008. This initiative provided porridge to public elementary students from pre-determined areas every day, conditional on school attendance.[20] During the high-price episode, the Government of Madagascar spent USD 3.9 million to expand the WFP's school feeding initiative to 150 000 children, an increase of 90 000.[21]

18 IRIN, "Afghanistan: Over 400 000 people receive food aid amid soaring prices", 13 April 2008 <http://www.irinnews.org/Report.aspx?ReportId=77739>.

19 Bulatlat, "Workers, Urban Poor Skip Meals to Cope with the Crisis", Vol. VIII, No. 27, 10-16 August, 2008, <http://www.bulatlat.com/2008/08/workers-urban-poor-skip-meals-cope-crisis>.

20 Bayan-natin, "What is up in the Philippines, President launches enhanced food for school feeding program", 31 July, 2008, <http://bayan-natin.blogspot.com/2008/07/president-launches-enhanced-for-for.html>.

21 IRIN, "Madagascar: Seasonal food shortages on the doorstep", 2 October 2, 2008 <http://www.irinnews.org/Report.aspx?ReportId=80705>.

Nine Asian, five African and four LAC countries took measures to increase salaries and other benefits of mainly public-sector employees. Such measures helped reduce tensions in urban areas, particularly in "administrative" cities where civil servants constitute an important element of the population. The proposal to raise public sector salaries by 30 percent in Egypt was a response to the unrest over high food prices.[22] Reportedly, the poorest Egyptians include many low-paid civil servants. Cambodia, Egypt, Ethiopia, Iraq and Syrian Arab Republic, among others, also took measures to increase salaries and benefits of public-sector employees.

However, public employees in many developing countries are generally economically better off than the average citizen, who is either unemployed or dependant on low-paying informal activities. Senegal undertook measures which were more in accordance with public sentiment: the President cut the number of ministers in his government by more than a quarter in December 2008 in a belt-tightening show of solidarity with citizens hit by rising fuel and food prices. El Salvador, Guyana and Panama reduced income tax for low-income groups, while Burkina Faso reduced the cost of electricity. But these measures did not help the poorest of the poor because, being unemployed, they are not subject to taxation and have no access to electricity anyway.

Three examples of targeted safety net measures

General subsidies are considered less efficient in reaching most vulnerable groups than targeted ones (see Chapter 24). They also impose a greater fiscal strain than targeted programmes. Countries with existing targeted safety net programmes responded to the high food price event in a more effective manner than those with no such programmes. The experience of three countries below reveals that the design of safety net programmes varies from country to country and has considerable implications on efficiency and equity.

Conditional cash transfer - Mexico's Progresa/Oportunidades

In Mexico, a CCT programme known as Progresa was a targeted scheme where cash was directly provided to beneficiary families (usually mothers) on the condition that children attend school and family members visit health centres regularly. Progresa was introduced in 1997 in response to the general perception that food subsidies such as the tortilla price subsidy (FEDELIST) were badly targeted towards poor households and were a substantial drain on the government budget. It has been shown that subsidized tortillas cost 40 pesos to transfer 100 pesos to beneficiaries (Coady, 2003). Progresa, which was renamed as Oportunidades in 2000, gradually replaced generalized food subsidies with direct monetary transfers. In 2002, the programme was expanded to include urban areas. The selection of eligible households occurs in three stages: first, potential recipient communities are identified as poor (using the marginality index developed in the national population census); second, potential participating households are selected (based on data collected from a household census within the community); and third, the list of potential participants is presented to the community assemblies for review and discussion. Cash transfers for education increase with the school grade (motivated by higher opportunity costs for older children in high schools) and are also higher for girls in middle school. Cash transfer for food involves monthly payment and is conditional on households making regular trips to health clinics for a range of preventive checkups as well as attendance at monthly nutrition and hygiene information

[22] Aljazeera, "Egypt increases public-sector pay", 30 April 2008 <http://english.aljazeera.net/news/middleeast/2008/04/2008614233237710513.html>.

sessions. Progresa was designed to be non-partisan and has clear eligibility criteria to prevent politicized benefit distribution.

In 2008, following the high food prices and the riots of 2007, the Mexican Government increased the programme's budget to 42 billion pesos, up from 39 billion in 2007. The budget may have been increased even further, as the President announced an increase in public expenditure to protect vulnerable people in the middle of the year. The number of beneficiaries increased by 1 million and the total number of Mexicans assisted by the programme reached 5 million households (one out of four Mexican families) in 2008. Payment to the poorest families also increased by 24.3 percent to an average of 665 pesos per month (from an average of 535 pesos per month). However, a comparison of the rate by which payments increased with the rate of inflation shows that beneficiaries were not fully protected from rising food inflation. A study by Valero-Gil & Valero (2008) concludes that the expense-weighted price change for the 11 most consumed food products increased by about 39 percent during the period 2006-2008. Although the programme did not fully compensate the increase in food prices, a very strong detrimental effect on the poor had been avoided thanks to Oportunidades and other safety net programmes. Mexico normally depends on the United States of America for 25 percent of its maize consumption, and annual inflation fell in early September[23] following the fall in world grain prices.

Progresa/Oportunidades has been credited with improving the health of children and adults, nutrition and growth of children and school enrolment. The programme has been shown, through a rigorous evaluation process, to have generated substantial improvements in human capital outcomes among the poor population it serves (Coady, 2003). It afforded an opportunity for the Government to rapidly respond to the turmoil in food markets. Its targeting methods were generally effective in ensuring that benefits reached the poorest households and administrative costs were kept to a minimum low. An International Food Policy Research Institute (IFPRI) study found that for every 100 pesos allocated to the programme, only 8.2 pesos were spent on administrative or programme costs (IFPRI, 2008).

Unlike non-conditional transfers, benefits in education, health and nutrition remain even after the programme disappears (World Bank, 2008c). A number of Latin American and Caribbean countries reinforced their CCT programmes. Brazil's Bolsa Familia programme, which covers 11 million families, increased the value of its transfers by 8 percent. The programme Bono de Desarrollo Humano in Ecuador planned to increase its coverage by 5.3 percent to reach 1.3 million people. Oportunidades was also hailed with enthusiasm in countries such as India (Kapur et al., 2008). However, there were some issues to be resolved, such as providing a way to encourage an exit from the programme when a household's socio-economic circumstances improve, overcoming gaps in coverage for key vulnerable groups as well as improving the effectiveness of human capital services which require closer attention. There is also the question of whether the kinds of conditionality found in Latin America can be adapted to countries with much weaker institutional capacity and delivery mechanisms.

Food based assistance - Bangladesh's PFDS[24]

The Government of Bangladesh attempted to stabilize food grain prices on the grounds that they are a crucial determinant of welfare for both producers and consumers, particularly for the poorest groups. The Public Food Distribution System (PFDS) was the main

23 Reuters, "Brazil cuts wheat sector taxes to ease inflation", 15 May, 2008 <http://uk.reuters.com/article/marketsNewsUS/idUKN1454178820080515>.
24 See FAO/WFP (2008).

instrument for stabilizing prices while at the same time making grains available to poor households who would not otherwise have access to adequate food, as well as for distributing food during emergency situations (MOFAD/WFP, 2005). The bulk of the PFDS' assistance (approximately two-thirds of the total food distributed during fiscal year 2007-08) was provided through seven channels: Open Market Sales (OMS), Vulnerable Group Development (VGD), Vulnerable Group Feeding (VGF), Food for Work (FFW), Test Relief (TR), Gratuitous Relief (GR) and Food Assistance for Chittagong Hill Tribes (CHT) Area. Grain was either purchased from the domestic market or imported from abroad.

Bangladesh's food-insecure population, estimated at 65.3 million, increased by 7.5 to 12.3 million in 2008, largely because of the impact of higher food prices. The undernourished population is believed to have increased from 27.9 million to 34.7 million after the price shock. It has been estimated (by the FAO/WFP Crop and Food Supply Assessment Mission, CFSAM) that approximately 30.5 million people were receiving assistance from the various programmes of the PFDS during the fiscal year 2007-08. The Government proposed to widen and deepen social safety net programmes (in response to the food shortage and high prices), but high local and international prices made it impossible to meet procurement targets and assist all poor families. The Government was unable to buy sufficient quantities from the local market, as it could only offer a procurement price that was 15 percent less than the market price in April 2008. The rice market in Bangladesh was also affected by the supply and demand situation in neighbouring countries. Export restrictions in India and the failure of Myanmar to honour its commitment to export to Bangladesh (because of the devastation caused by Cyclone Nargis) added to the tightening of the PFDS' supplies. The price of rice increased by about 52 percent in August 2008 (over August 2007) and failed to come down in July and August, when world prices started declining. Protests against the high prices were held twice (in April and June), and the Government was forced to set up army-led joint forces to monitor prices during the month of Ramadan in order to ensure that traders could not make large profits by charging high prices.[25] The Government initiated open market selling of rice from 20 August to 31 October 2008 to help the poor during the festivity season. A total of nearly 300 000 tonnes of rice was expected to be sold with a rate of USD 0.41 per kg. The Food Ministry was also given the mandate to import food to meet emergency needs without going through the usual tender process.

Non-government sources of food security also played a critical part in providing assistance to a large number of poor households in Bangladesh. NGOs such as CARE and Save the Children-US (United States Agency for International Development (USAID) PL 480 Title II NGOs) were reported to have provided food assistance to about 4.8 million people. The WFP was assisting approximately 4.7 million people at that time (3.8 million of whom were also beneficiaries of government programmes). BRAC, Bangladesh's largest NGO, was reported to be assisting 1.4 million people with food rations and cash assistance. There were various other NGOs operating similar programmes; a FAO/WFP mission estimated that as many as 8.1 million people, representing just over 12 percent of the estimated food insecure population, were recipients of assistance from non-government channels. This implies that government and non-government safety net programmes were unable to reach a significant proportion of the vulnerable population in Bangladesh in 2008. An FAO mission visiting the country in April/May 2008 estimated that about 37 percent of households reported consuming less than three meals per day because of high food prices (FAO/WFP, 2008).

25 The Daily Star, "Ministry can skirt purchase rules for urgent food import"; UNB, Dhaka, July 25, 2008, in Amader Krishi, <http://amaderkrishi.wordpress.com/category/foodimport/>.

The grain reserve enabled Bangladesh to rapidly respond to humanitarian needs, but maintaining reserves had significant cost implications. Unlike the open-market sales of grain from the reserve, the public stock releases for relief did not generate income with which the reserve could be replenished. The Government did inject scarce additional finance at the expense of funding for other programmes. Thus the PFDS faced the complicated task of managing its stock, averaging between 0.7 and 1.0 million tonnes, in a manner that was not too costly and did not affect market functioning when released.[26] The use of food subsidies as social protection has been discredited in recent years because of the high cost of handling and the huge subsidy requirements. Food transfer is more costly than distributing cash, as it involves inter-continental shipments (some 30-35 percent additional cost) or local procurement (5-10 percent extra cost according to WFP, 2006). Declining world food prices also made it cheaper to buy food from world markets than to subsidize the consumption of domestically produced food. Nevertheless, events in world food markets - notably restrictions by exporting countries and unprecedented price hikes - have placed the issue of public stocks back on the policy agenda. Food transfer remains the favoured intervention in acute emergencies and conflict situations and under general conditions of food shortages and rising prices (see for instance the Ethiopian case below). Food market turbulence in Bangladesh would probably have been worse had there been no public stocks and public distribution system in place. The Government's policy of maintaining public stocks to provide price support to producers as well as to protect consumers appears to have been a rational response to the high and continued risk of frequent cyclones and floods and very high levels of poverty in the country. However, a more concerted effort and the channelling of additional resources would be required for food-based safety net programme to effectively cope with high food prices, large numbers of food-insecure people and the unprecedented natural disasters that Bangladesh faces year in and year out.

Employment-based safety net programme - Ethiopia's PSNP

In 2005, the Government of Ethiopia revised its strategy of distributing food aid by shifting from a relief-oriented to a productive and development-oriented safety net approach in areas suffering from chronic food insecurity. The focus of the new programme, known as the Productive Safety Net Programme or PSNP, was to provide more reliable and timely support to chronically food-insecure households in more than 260 counties. The number of beneficiaries increased from five million people in the first year to over eight million in 2008. Technical and financial support is provided by a joint donor group that includes, among others, the UK's Department for International Development (DFID), USAID, the World Bank, the European Commission and the WFP. The PSNP is designed with the objective of mobilizing labour for public works activities that build infrastructure and assets to promote agricultural productivity and access to markets (e.g. feeder roads, soil and water conservation, micro-dams for irrigation) while contributing to smoothening food consumption and protecting household assets or preventing impoverishment. People facing predictable food insecurity are targeted and offered guaranteed employment for five days a month in return for transfers of either 15 kg of cereals or cash equivalent of USD 4.00 per month for each household member. Households with no labour and no other means of

[26] Although low by international standards, food aid leakages owing to inefficient transport and handling, short ration and under-coverage have been reported in the past in Bangladesh. Empowerment of women at the union level to hold programme managers accountable is reported to be one of the reasons for the low level of leakages (Ahmed et al., 2004).

support are eligible for direct support at the same levels. The goal is to achieve "graduation" of beneficiaries after three to five years of cash or food transfers complemented by regular government support measures to improve agricultural productivity and transform rural livelihoods. Graduation means the household is no longer chronically food-insecure and also has the economic resilience to resist falling back into chronic food insecurity in the future (Devereux et al., 2006).

In response to the high price episode of 2006-08, the Government of Ethiopia relied on donors to provide additional support to PSNP participants and new relief aid for non-PSNP rural areas affected by the high prices. The wage rate for public work programmes was increased by 33 percent in January 2008 (World Bank, 2008c). But high food prices affected other parts of the country as well. The number of rural people (from non-PSNP areas) that depended on the food assistance of various non-government organizations increased from 4.6 to 6.4 million by August 2008. In urban areas, the Government took the responsibility of selling subsidized wheat obtained from the strategic grain reserve and from imports. The urban scheme was estimated to have benefited about 4.5 million people. However, prices continued to rise and maize prices escalated by 132 percent in August 2008 compared with August 2007, straining safety net outreach. Demand for food transfers increased sharply in the PSNP areas, since even before the price surges (i.e. 2006), the majority of households preferred food only (54 percent), followed by half food, half cash (36 percent), while less than one in ten preferred cash only (9 percent). Fungibility of cash and high food prices are cited to be among the major reasons that food was preferred in 2006 (Devereux et al., 2006). The WFP also reported shortfalls of 66 362 tonnes, 36 148 tonnes and 4 983 tonnes of food items for its relief, the PSNP and Targeted Supplementary (TSF) programmes in September, October and November 2008 respectively.

Ethiopia's employment-based safety net programme is a strategic move to end dependence on food aid and create more sustainable livelihoods. But several challenges warrant closer attention. High price episodes and drought clearly demonstrate that vulnerability remains a major concern. Addressing the problems of drought and land degradation - the main causes of vulnerability in chronically food-insecure areas - requires a higher level of support at the household level and major investments in irrigation, soil conservation and alternative sources of livelihoods, among other needs. The provided support is deemed too little to induce significant investment in farm or in non-farm activities. Measures aimed at preventing price increases also act as a disincentive to farmers and traders. A substantial amount of resources, as well as increased institutional and technical capacity, are required for Ethiopia's new safety net programme to achieve the desired goal of ending food aid dependence and stimulating sustainable livelihoods.

Producer-oriented measures

Producer-oriented measures include actions directed at supporting producers through non-market and market mechanisms. Among the 81 countries monitored, non-market based measures such as production support were reported by 35 countries, productive safety nets by 15 countries and fertilizer and seed programmes implemented by ten countries (Table 10.4). [27] On the other hand, only 15 countries carried out market intervention measures that included

[27] Production support measures mainly include production subsidies, untargeted input subsidies and improved access to credit. Seed and fertilizer programmes are largely aimed at improving availability, while productive safety net programmes refer to targeted input subsidies (to support poor producers).

support to value chain management, producer price and market information. Below we discuss experiences of implementing some of the main producer-oriented measures as well as implications and emerging trends.

Producer-support measures in developing countries

Policy response must find the right balance when addressing the impact of soaring food prices on producers and consumers. In the short-term, food or cash transfer can be an effective emergency policy response to support consumers, but they may have a disruptive impact on local production and consumption patterns. Such effects can be mitigated by adopting measures that support producers. Producer-support measures took the form of productive safety nets such as input vouchers and input subsidies in Bangladesh, Dominican Republic, Indonesia and Madagascar. In some cases, these measures were accompanied by actions to improve access to funds and credit facilities, reduction of import taxes, exemption of producers from the payment of taxes on fertilizer and farm machinery, and by governmental purchase or governmental price support to smallholder producers.

In Bangladesh, the Government supported farmers by procuring rice at a higher price and providing subsidies in the form of cash transfers to poor and marginal farmers to mitigate the higher costs of irrigation and fertilizer. In June 2007, the Government also committed to subsidizing the extra diesel cost that poor farmers had to endure on account of the fuel price hike for their diesel-driven irrigation pumps. Farmers using electric-powered pumps were also promised continued benefits from a 20 percent subsidy against their electricity bills. The fertilizer subsidy was also increased significantly in the 2007-08 budget. But Bangladesh loses 0.6 percent of its agricultural land annually, and increasing productivity on declining farmland has become a huge challenge.[28]

India also raised its minimum support price for food grains and maintained (and expanded in some cases) its subsidy on fertilizer (paid to manufacturers and importers), irrigation and power. In February 2008, the Indian Government announced a plan to cancel the entire debt of the country's small farmers in a giant scheme estimated to cost about USD 15 billion.[29] India's 2008-09 budget also included a provision to significantly increase subsidized agricultural credit, boost investment in water resource development, establish the Irrigation and Water Resources Finance Corporation (IWRFC) for funding major and medium-sized irrigation projects, increase funding for crop insurance and revive cooperative credit structures.[30] But questions remain about the sustainability and effectiveness of India's huge and expanding subsidy programme. Moreover, while Indian agriculture has been successful in increasing food grain production in the past, it has also become very difficult to sustain growth owing to recent environmental degradation (Abrol & Sangar, 2006).

In March 2008, China (Mainland) promised to increase financial support for agricultural production with the objective of curbing inflation that was blamed on food shortages and rising prices. China (Mainland) raised the minimum purchase prices for wheat and rice and improved financial services available to farmers. It also increased subsidies for seeds and other inputs and allocated more funds for flood and drought preparedness and for agricultural infrastructure (IFPRI, 2007). The Central Government's budget earmarked for

28 Bangladesh News, "Bangladesh Budget 2007 – 2008: Text of Finance Advisor's Speech", 8 June , 2007.

29 International Herald Tribune, "India waives loans to poor farmers in annual budget ahead of likely elections", 29 February, 2008.

30 "Minister of Finance, Union Budget 2008 – 2009 Speech" <http://indiabudget.nic.in/ub2008-09/bs/speecha.htm>.

agriculture, farmers and rural areas increased by 30 percent in 2008 (compared with 2007[31]). Despite these measures, China (Mainland) was expecting its food deficit to grow and looked for a new and unprecedented measure to ensure food security.

A few African countries, including Madagascar, Malawi, the United Republic of Tanzania and Zambia attempted to introduce or expand input (mainly fertilizer) subsidy programmes. However, only Malawi is regarded to have in place a well-designed targeted input subsidy programme in Africa. The subsidy programme in 2006/07 included the sale of 175 000 tonnes of fertilizer and 4 500 tonnes of seeds of hybrid maize and open pollinated varieties to targeted farmers with a 72 percent subsidy (i.e. farmers paid only 28 percent). Programme costs were just under USD 91 million, with 87 percent funded by the Government of Malawi.[32] It is estimated that maize production increased by 26 percent in 2006/07. The Government also continued distributing coupons that allowed poor smallholder farmers to buy fertilizer and seeds at close to 80 and 100 percent subsidy, respectively, in 2007/08.[33] Input subsidy programmes in many other African countries are still subject to policy-makers' reluctance to re-introduce subsidies and are absent also owing to a lack of budgetary resources.

Some African countries opted for the promotion of home gardens and off-season utilization of irrigated land to produce short-duration vegetables and other crops. For example, in the peri-urban area of Bangui, the capital of the Central African Republic, the Government allocated money to promote the cultivation of maize, rice, cassava and poultry farming of one-day-old spring chickens. In Benin, an Emergency Programme was established for immediate production of off-season short-cycle rice and maize. The FAO supported the off-season planting of rice in July and August in Madagascar by providing rice and bean seeds plus fertilizers to some 6 000 farmers hit hardest by cyclones.

The policy challenge of protecting consumers while allowing small producers to benefit from the high prices has not been easy in many countries, especially in those that are poor and food-insecure. Poor infrastructure, day-to-day price instability as well as policy measures limiting the transmission of high prices to producers, coupled with high prices of fertilizer, discourage small farmers from investing in productivity-enhancing technologies. The 2006-08 high price event failed to trigger a concerted effort to improve transport and communication infrastructure, greater investments in soil and water conservation, enhancements of small-scale irrigation and extension services and other measures in many of the poorest countries.

Production response is also constrained by the high cost of fertilizer. International fertilizer prices more than doubled in the space of a few months during 2008, while China (Mainland) imposed 150 percent export tax on fertilizer. High fertilizer prices also led to riots among smallholder farmers in developing countries. Fertilizer protests were reported in Egypt, India, Kenya, Nepal, Nigeria, Pakistan, Taiwan and Viet Nam.[34]

While smallholders protest the unaffordability and inaccessibility of fertilizers, large commercial farmers in developed and most food-exporting countries appear to have benefited from high food prices. Cereal production in developed countries increased by 11 percent between 2007 and 2008 - largely by expanding production on land set aside previously by regulation - while at the same time, developing countries' production increased only by 0.9 percent.[35]

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31 China Gate, "China giving greater support to agriculture to cool inflation", 27 March, 2008.
32 ASARECA, PAAP's Electronic Newsletter, 14 November, 2008, Volume 11, Number 22.
33 FEWSNET, Malawi Food Security Update, November 2007.
34 The Guardian, "Soaring fertilizer prices threaten world's poorest farmers", 12 August, 2008.
35 Production in developing countries actually decreased by 1.6 percent over this period if one excludes Brazil, India and China (Mainland) from this group, (FAO, 2008a).

International support

During and after the episode, FAO distributed key agricultural inputs in more than 80 countries through its Technical Cooperation Programme (TCP) projects and some donor-funded activities. TCP projects are estimated to have benefited 370 000 smallholder farmer households and their dependents. The World Bank also announced a USD 1.2 billion fast-track facility for dealing with the turmoil that included not only financing for emergency food assistance, but also funding for seeds, fertilizer, irrigation, and crop and livestock insurance for small-scale farmers. The European Commission was in the process of creating a one billion Euro fund to help farmers in developing countries. The High-Level Conference convened by FAO (3 to 5 June 2008) called on the international community to take urgent and coordinated action to combat the negative impacts of soaring food prices on the world's most vulnerable countries and populations. At the conference, many G8 countries responded to the call and announced that they would significantly increase funding in response to the turmoil (around USD 10.6 billion), which added to prior announcements of more than USD 13 billion. But deployment of these funds was slow and only a small proportion of the declared amounts were actually disbursed. The financial crisis that emerged afterwards dampened the prospect of increased financial assistance, particularly as international food prices sharply declined in the latter part of 2008.

The macroeconomic implications and food price impacts of the policy responses

The different policy responses - market and trade measures, safety net programmes and production support measures - were aimed at easing the high price burden. In the following section, we consider the macroeconomic implications of these measures and the extent to which prices have been contained relative to international prices as a result of these interventions.

Macroeconomic cost implications

The policy responses to high food prices have implications for macroeconomic stability of many developing countries. Government responses to mitigate the impact of the food security threat have required increased public outlays with adverse implications for financing basic services. In particular, poorer countries have been faced with the challenge of financing subsidies, social protection and food as well as fuel imports. Several countries had to draw down their foreign exchange reserves or resort to domestic borrowing, risking reallocation of resources, higher inflationary pressures and balance of payment difficulties.

The total expenditure on food subsidies has been projected to exceed 1 percent of GDP in six countries, namely Burundi, Egypt, Jordan, Maldives, Morocco and Timor-Leste in 2008. The total transfer cost (including agricultural subsidies) is projected to be between 2 and 4.5 percent of GDP in Bangladesh, Belize, Iraq, Malawi, Mauritania, Mexico, the Philippines and South Africa in 2008. In Malawi, the transfer cost, estimated at about 2.6 percent of GDP (approximately 15 percent of government expenditure), is entirely devoted to supporting poor farmers, while nearly all targeted expenditures in Belize, Iraq, Mexico and South Africa are used to support poor consumers. Bangladesh and the Philippines allocate between 30 and 40 percent of their total transfer budget to assisting poor producers (IMF, 2008b).

The fiscal cost of high food prices is particularly significant in poor countries that are more exposed to international food and fuel price shocks as they cumulate the negative effects on public finance and inflation of both crises. Countries such as Djibouti, Eritrea, the Gambia, Haiti, Sierra Leone, Tajikistan and Togo potentially face a fiscal cost that is beyond their budgetary means. The effort to control inflation is also proving difficult as high food and energy prices are placing further pressure on fiscal expenditures of several countries (World Bank, 2008a). A cash injection can also result in local inflation where markets are not functioning well and food items are in short supply (World Bank, 2008b).

Response to high food prices have also absorbed a significant amount of foreign exchange in many countries, especially in those with low capacity to import when measured by the value of food imports as a share of foreign exchange reserves. The impact of the 2008 food and fuel price increases could exceed 50 percent of the initial international reserve for eight African countries, namely the Democratic Republic of Congo, Eritrea, Ethiopia, Guinea, Liberia, Madagascar, Malawi and Zimbabwe (IMF, 2008a). An IMF study estimated a rise in the food import bill of USD 7.2 billion, or 0.3 months of imports for 43 net food-importing countries with available data (IMF, 2008c).

Achievements in bringing down domestic food prices

Food riots in several countries, including Bangladesh, Burkina Faso, Cambodia, Cameroon, Cîe d'Ivoire, Egypt, Indonesia, Mauritania, Senegal and Yemen forced governments to act. Many countries applied a combination of measures to counter rising food prices, which were viewed as threats to political stability. In April 2008, African finance ministers warned that the rise in international food prices was a serious threat to the continent's growth, peace and security (Patel, 2008). The impact of the different policy responses in containing increases in food prices was examined using data for four major food crops, namely rice, wheat, maize and millet. A total of 28 countries with relevant price data have been considered, and the results show that the effort to keep down prices vary from country to country and from crop to crop.

Rice

International rice prices rose to unprecedented levels in May 2008 but eased slightly in recent months. Nonetheless, prices remained very high, and by August 2008, Thailand white (first grade) rice was 135 percent above its level a year before while the price of broken (second grade) was 95 percent higher (Table 10.1). Table 10.5 shows that domestic rice prices in the countries under consideration did not increase by as much as the international prices in most cases. The policy responses seemed to have prevented the full transmission of the unprecedented price hike on the international rice market to domestic markets.

In West Africa, the price of imported rice rose by 43 percent in Mali, 50 percent in the Niger and 65 percent in Burkina Faso in August 2008 (compared with August 2007). Senegal experienced the highest price surge (112 percent). Unlike many West African countries, where cereal imports accounted for less than 10 percent of the total consumption (during the period 2003/04 to 2006/07), Senegal depends heavily on cereal imports, accounting for 53 percent of its domestic requirement.[36]

In Asia, where rice is the dominant staple crop, rice prices increased at a much lower rate than the international price for most of the countries for which data are available. The highest rate of increase was 75 percent in Sri Lanka followed by 52 percent in Bangladesh,

36 All cereal import figures are from FAO/ GIEWS.

compared with a 95 to 135 percent increase in world rice market prices.[37] On the other hand, rice prices increased by only 26 percent in India and China (Mainland). Both countries restricted export and relied on government market intervention to prevent the transmission of international prices to local markets. China (Mainland) and India have also benefited from limited dependence on imports: cereal imports accounted for only 1 and 1.5 percent of total domestic use in India and China (Mainland), respectively, during the period 2003/04 - 2006/07.

In LAC, rice price increases were relatively more pronounced (than in Asia and Africa), ranging from 85-90 percent (Chile, El Salvador and Haiti) to 102 percent (the Plurinational State of Bolivia).[38] Prices increased by 46-65 percent in Guatemala, Honduras, Nicaragua and Peru (Table 10.5). Import dependence is generally high for most LAC countries, exceeding 40 percent for most of the countries under consideration. A significantly lower rate of price increase was observed in the case of the Dominican Republic (25 percent), and this is mainly owing to the excellent spring rice harvest that started in May 2008.[39]

Wheat

Although they declined after the peaking June 2008, in August 2008 world wheat prices (United States No.2, hard red winter wheat f.o.b. Gulf) were still 24 percent higher compared with a year earlier and in Argentina wheat prices (Up river f.o.b.) were 12 percent higher (Table 10.1). Domestic prices, however, of wheat in countries such as Afghanistan, Eritrea, Ethiopia, Sri Lanka and Sudan increased more rapidly (from 46 to 130 percent) than the international markets. In Eritrea, where wheat is the main staple and is fully imported, prices more than doubled by August 2008. The policy responses would appear to have brought limited relief in the case of wheat for these countries. However, the price surge could have been worse were it not for the actions such as releasing stocks (e.g. Afghanistan, Eritrea and Ethiopia) and tax reduction (e.g. Ethiopia and Sudan).[40] Most of these countries were also affected by natural disasters or conflicts. A decline in the amount of food aid distribution has also contributed to the price increase in countries such as Ethiopia (Demeke et al., 2007).

Maize and millet

World maize prices have followed a pattern similar to wheat, although the rates at which prices increased were higher for maize: United States maize increased by 53 percent while Argentina maize increased by 39 percent in August 2008. Domestic maize prices in Ethiopia, Kenya, Malawi and the Republic of Mozambique increased at a faster rate than world maize prices, varying from 59 percent to 157 percent (Table 10.5). These countries are all very poor and have limited resources to import and increase domestic supply. The price of millet (locally produced) also increased by 28-46 percent in Burkina Faso, Mali and the Niger. By contrast, export prices weakened in South Africa following a bumper harvest. Maize prices in El Salvador, Haiti and Nicaragua also declined or increased only marginally as a result

[37] The price surge in Sri Lanka may be attributed to the high level of dependence on cereal import (37 percent) and the high inflationary pressures, which peaked at 28.2 percent in June 2008 (Sri Lanka Today, "Sri Lanka's 'underlying' inflation in new trouble, as Thailand dumps core", 6 September 2008 <http://srilankatoday.com/index.php?option=com_content&task=view&id=2>).

[38] Haiti and the Plurinational State of Bolivia have also been listed as vulnerable countries by WFP.

[39] Oryza News, "Dominican Republic: an excellent harvest of rice is expected", 8 May, 2008 <http://oryza.com/news/Dom-Republic-rice-harvest.html>.

[40] Prices in Pakistan seem to have changed very little but this is because the quotations were in United States Dollars. Prices in local currency increased until August, see FAO (2008c).

of good maize harvests (in 2007) and the policy measures taken by governments to reduce prices of imported maize.

Price developments: July - September 2008

Prices of rice, wheat and maize declined on international markets in July and August. On a monthly basis, rice prices on the world market declined by 4 to 10 percent, wheat by 5 to 9 percent[41] and maize by 2 to 14 percent in July and August 2008 (Table 10.1). But the evidence shows that the decline was not immediately reflected in local grain prices in most the countries under consideration: in July 2008, the price of rice increased in 14 countries and decreased in only 3. In August, rice prices continued to rise in 6 countries, decreased marginally in one (Sri Lanka) and showed no change in 4 countries.[42] The situation in the case of maize was less encouraging: prices continued to rise in most cases in July and August. Wheat prices tended to decline in some cases, but mostly remained volatile in July and August (Table 10.5).

In September, international prices of rice, wheat and maize declined further: rice by 3 to 7 percent, wheat by 8 to 10 percent and maize by 1 to 3 percent (Table 10.1). However, the number of domestic grain markets that experienced price increases for primary food commodities was greater than those that witnessed a price decline. According to USAID's sample survey of 183 markets in 25 countries, this occurred in 19 countries from Africa, one from the Caribbean, two from Central America and two from Central Asia. The price of primary food commodities increased in 85 markets (46.5 percent), declined in 60 markets (32.8 percent) and showed no change in 38 markets (20.7 percent). The highest increases (greater than 34 percent) were recorded in Haiti, Nigeria, Senegal, parts of Somalia and Zimbabwe.[43]

Price declines were attributed to good production prospects and the consequences of the global financial crisis and the accompanying economic slowdown (von Braun, 2008).

Response to the turmoil: paradigm change?

Responses of developing countries to food insecurity during 2006-08 appear to have been in contrast with the policy orientation most had pursued in the preceding decades as a result of implementation of the Washington consensus supported by the Bretton Woods Institutions. This period was characterized by increased reliance on the market - both domestic and international - on the grounds that this reliance would increase resource allocation efficiency, and by world prices serving as a reference for measuring economic efficiency. The availability of cheap food on the international market was one of the factors that contributed to reduced investment into and support of agriculture by developing countries (and their development partners), which is generally put forward as one of the reasons for the price turmoil. This increased reliance on markets was also concomitant to a progressive withdrawal of the state from the food and agriculture sector on the grounds that the private sector was more efficient from an economic point of view.

The 2006-08 event has revealed some drawbacks of this approach. Countries depending on the world market have seen their food import bills surge while their purchasing capacity has decreased, particularly in the case of those countries that also had to face higher energy

41 With the exception of August, United States wheat which remained largely unchanged.
42 Price information was not available in the case of seven countries for August 2008.
43 FEWSNET, Price Watch: urban markets, September 2008.

Table 10.1: Selected international cereal export prices

	Annual Changes Aug 07/Aug 08	Monthly Changes		
		Aug 08	July 08	September 08
United States				
Wheat [1]	24.28	-4.75	0.59	-10.20
Maize [2]	52.63	-4.98	-13.11	-1.29
Sorghum [2]	22.22	-13.43	-9.91	-0.48
Argentina [3]				
Wheat	12.45	-9.37	-6.69	-7.82
Maize	39.10	-2.33	-13.89	-6.45
Thailand [4]				
Rice white [5]	134.93	-4.02	-5.75	-2.92
Rice, broken [6]	95.17	-9.61	-9.95	-7.24

import prices. This situation was further aggravated when some important export countries, under intense domestic political pressure, applied export taxes or bans in order to protect their consumers and to isolate their prices from world prices.

As a result, several countries have decided to change their approach, questioning de facto the paradigm that had guided their policies and strategies during the last decades:

- By trying to isolate domestic prices from world prices (exporting countries);
- By moving from a food security based strategy to a food self-sufficiency based strategy;
- By trying to shunt "normal" international trade processes either by acquiring land abroad for securing food and fodder procurement or by trying to engage in trade agreements at the regional level;
- By showing distrust towards the private sector (price controls, anti-hoarding laws, government intervention in output and input markets).

Isolation from world markets

As the analysis in this chapter has shown, 25 countries restricted or banned food exports in order to reduce transmission of increased world prices to their domestic markets.

Food self-sufficiency

Several countries, including China (Mainland), Indonesia, Malaysia, the Philippines and Senegal, have now declared food self-sufficiency as their strategic response to high food prices. For example, the Government of the Philippines, the biggest rice importer in the world, is seeking to achieve 98 percent self-sufficiency in rice by 2010. This clearly represents a change in policy orientation from food security to food self-sufficiency.

Similarly, the President of Indonesia recently stated that the country must become food self-sufficient and that global food production had been compromised by events in 2006-08. "Indonesia must struggle to reach food self-sufficiency, and learn not to rely on other countries because we have our own good resources with which to develop the agriculture

Table 10.2: Market and trade-based policy measures adopted (as at 1 December 2008)

Region	Domestic Market Based Measures			Trade Policy Measures	
	Release stock (public or imported) at subsidized price	Suspension/ reduction VAT and other taxes	Admin. price control or restrict private trade	Reduction of tariffs and customs fees on imports	Restricted or banned export
Asia (26 countries)	Bangladesh Cambodia China India* Iraq Jordan Lebanon Malaysia Nepal Pakistan Philippines Republic of Korea Thailand Viet Nam Yemen	Azerbaijan China Indonesia Jordan Mongolia	Bangladesh Jordan Malaysia Pakistan Republic of Korea Sri Lanka	Azerbaijan Cambodia China Indonesia Iran (Islamic Republic of) Jordan Lebanon Pakistan Philippines Republic of Korea Saudi Arabia Turkey Yemen	Bangladesh Cambodia China India Iran (Islamic Republic of) Jordan Kazakhstan Lebanon Myanmar Nepal Pakistan Syrian Arab Republic Viet Nam
	15	5	6	13	13
Africa (33 countries)	Algeria Benin Cameroon Egypt Eritrea Ethiopia Kenya Malawi Mauritania Nigeria Senegal Sierra Leone Togo	Burkina Faso Congo Djibouti Ethiopia Côte d'Ivoire Kenya Lesotho Madagascar Morocco Mozambique Senegal Sudan Uganda	Benin Cape Verde Djibouti Ethiopia Côte d'Ivoire Malawi Morocco Senegal Sudan Togo	Benin Burkina Faso Cameroon Cape Verde Gambia Ghana Guinea Côte d'Ivoire Kenya Liberia Libyan Arab Jamahiriya Madagascar Mauritania Morocco Niger Nigeria Rwanda Senegal	Cameroon Egypt Ethiopia Guinea Kenya Malawi United Republic of Tanzania Zambia
	13	14	10	18	8
Latin America & Caribbean (22 countries)	Bolivia (Plurinational State of) Brazil Costa Rica Dominican Republic Guatemala Guyana Honduras	Brazil Dominican Rep. Guyana Suriname	Belize Costa Rica El Salvador Mexico Saint Lucia	Argentina Bahamas Belize Bolivia (Plurinational State of) Brazil Ecuador El Salvador Guatemala Mexico Nicaragua Peru Trinidad & Tobago	Argentina Bolivia (Plurinational State of) Brazil Ecuador
	7	4	5	12	4
Total	35	23	21	43	25

Table 10.3: Countries that introduced safety net programmes in response to high food prices

Region	Safety net (increased or introduced)		Increase disposable income
	Cash transfer	Food assistance	
Asia (26 countries)	Bangladesh China India Indonesia Jordan Pakistan Saudi Arabia Yemen	Afghanistan Bangladesh Cambodia India Indonesia Iraq Jordan Republic of Korea Saudi Arabia	Bangladesh Cambodia Jordan Iraq Lebanon Saudi Arabia Syrian Arab Republic Yemen
	8	9	8
Africa (33 countries)	Burkina Faso Egypt Ethiopia Liberia Mozambique South Africa	Angola Ethiopia Liberia Madagascar Nigeria	Cameroon Egypt Ethiopia Libyan Arab Jamahiriya
	6	5	4
Latin America & Caribbean (22 countries)	Brazil Chile Costa Rica Ecuador El Salvador Guyana Haiti Mexico Suriname	Bahamas Guatemala Haiti Peru Suriname	El Salvador* Guyana* Honduras Panama* * Reduced income tax for low income group
	9	5	4
Total	23	19	16

sector", he declared. Food self-sufficiency is to be achieved though increasing subsidy for seeds, fertilizers and loan schemes for farmers.[44]

Senegal consumes about 800 000 tonnes of rice per year and nearly 80 percent of this is imported, making it one of the top-ten importers in the world. As one of the countries hardest-hit by the turmoil, evidenced by widespread riots during the episode, the President unveiled an ambitious agricultural plan called the Great Offensive for Food and Abundance (GOANA), which aims to make Senegal self-sufficient in food staples, especially rice. The target is to produce 2.5 times more than current production.[45]

The episode has also brought a renewed emphasis on domestic food production in many Latin American and Caribbean countries that have been relying heavily on food imports. For instance, Colombia, which imports 60 percent of its requirements of maize (3.4 million tonnes) and 96 percent of wheat (1.4 million tonnes), has begun supporting its farmers with

44 The Jakarta Post, "Food self-reliance national priority: SBY", 27 November, 2008.

45 African News Network, "Food insecurity complicates land use for biofuel crops in Southern Africa", 19 November, 2008, <http://www.africanagricultureblog.com/2008/11/food-insecurity-complicates-land-use.html>.

Table 10.4: Short-term measures aimed at supporting producers and production

Region	Non-Market Based Production Support Measures			Market-Based Intervention
	Production Support Programmes	Productive Safety Nets	Fertilizers and Seeds Programmes	
Asia (26 countries)	Azerbaijan Bangladesh China Indonesia Malaysia Mongolia Myanmar Pakistan Republic of Korea Syrian Arab Republic Tajikistan	Bangladesh Indonesia Iraq Philippines	Pakistan Philippines	Afghanistan Bangladesh China India Lebanon Nepal Pakistan Turkey Yemen
	11	4	2	9
Africa (33 countries)	Algeria Benin Burkina Faso Central African Republic Ghana Liberia Libyan Arab Jamahiriya Madagascar Nigeria Senegal Seychelles Tunisia	Guinea Kenya Liberia Madagascar United Republic of Tanzania Tunisia	Burkina Faso Nigeria Tunisia Zambia	Algeria Egypt Ethiopia Tunisia
	12	6	4	4
Latin America & Caribbean (22 countries)	Antigua and Barbuda Belize Brazil Costa Rica Dominican Republic Guyana Haiti Jamaica Nicaragua Peru Suriname Trinidad and Tobago	Dominican Republic El Salvador Jamaica Nicaragua Trinidad and Tobago	El Salvador Jamaica Trinidad and Tobago	Brazil Honduras
	12	5	3	2
Total	35	15	9	15

credit to produce maize and wheat. Focusing too heavily on export crops such coffee, banana, tropical fruits and beef is considered to have adversely affected the food security situation of the country. There are also calls for expanding area under food crops, removing the huge subsidies and incentives granted for biofuels and reducing area under cattle ranching to make Colombia not only food self-sufficient, but also able to generate exportable surpluses. In

Table 10.5: Domestic food grain price changes for selected countries (in percent)

		Annual Changes	Monthly Changes	
		Aug 08/Aug 07	July 08	August 08
Imported Rice	Niger	50.00	11.76	18.42
	Mali	43.14	7.35	0.00
	Burkina Faso	64.58	-12.22	0.00
	Senegal	112.27*	53.11	n.a
Local rice	Madagascar	35.73	12.98	4.13
	Bangladesh	51.61	6.82	0.00
	Sri Lanka	74.62	-5.06	-0.69
	India	25.79	5.22	n.a
	China	26.36	0.56	n.a
	El Salvador	85.29*	n.a	n.a
	Nicaragua	65.70	9.84	1.55
	Guatemala	46.05	3.26	n.a
	Honduras	53.77	3.82	n.a
	Haiti	89.35	5.18	41.33
	Dominican Rep.	25.36	3.79	2.46
	Peru	48.12	6.67	2.60
	Chile	89.58	-5.30	0.00
	Bolivia (Plurinational State of)	102.43	2.56	n.a
Wheat	Sudan	59.66	24.30	n.a
	Eritrea	115.25	0.00	n.a
	Ethiopia	85.30	3.21	n.a
	Afghanistan	129.63	-1.61	1.64
	Pakistan	4.38	0.00	-1.76
	Sri Lanka	45.75	-0.86	-2.76
Maize	Kenya	58.62	4.94	-5.29
	United Republic of Tanzania	39.53	-3.24	0.42
	Ethiopia	132.64*	5.04	n.a
	Malawi	157.04*	48.98	n.a
	Mozambique	86.64	16.62	9.50
	South Africa	-3.95	1.58	-5.45
	El Salvador	-3.84*	n.a	n.a
	Haiti	10.20	-3.70	-3.84
	Nicaragua	5.41*	-2.50	-2.56
Millet	Niger	39.29	11.76	2.63
	Mali	28.00	10.71	3.23
	Burkina Faso	45.83	6.25	2.94
	Senegal	8.52*	0.00	n.a

* Price changes refer to July 2008/July 2007.

Honduras, the President launched the Plan for Supply of Basic Grains and the Technological Productive Voucher (BTP) to reach self-sufficiency in basic grains to feed its population of 7.3 million people. There are provisions of some basic inputs in terms of agricultural credit at low interest rates (lowered from 24 to 9 percent) for seeds, technology, etc. The policy that encouraged rice imports from the United States (starting in the early 1990s) as a cheap alternative in Honduras is now viewed as undesirable as it has driven rice farmers into bankruptcy (IRRI, 2008).

Shunting "normal" international trade processes

Regional cooperation: Doubting that national self-sufficiency goals can be met by small countries in a risky international environment, several regions have taken steps toward improving food security through regional cooperation to reduce dependence on imports from outside the region. For example, in August 2008, the Southern African Development Community (SADC) announced that it would establish a Regional Food Reserve Facility while urging member states not to impose export restrictions on maize.[46] Kenya, Uganda and the United Republic of Tanzania are discussing the possibility of setting up a regional fertilizer plant to offset high costs and ensure long-term sustainable supplies.[47]

In Asia, the Greater Mekong Sub-region (GMS) intends to intensify integration of agricultural trade and establish a more equitable way to share the gains from agricultural growth. In Latin America and the Caribbean, some countries are working on integrated national plans (e.g. the Costa Rican National Food Plan). Groups of countries are signing regional agreements, such as the Plurinational State of Bolivia, Cuba, Nicaragua and the Bolivarian Republic of Venezuela, which have agreed on a USD 100 million fund to finance multilateral cooperation on the theme of "Food Sovereignty."

The 2006-08 high price episode also encouraged solidarity among neighbouring countries and among some developing countries. In April 2008 Malawi announced a ban on maize exports to all countries except Zimbabwe to shore up the country's dwindling stocks. India partially lifted its maize export ban and allowed the WFP to buy maize for distribution to three African countries.

International land acquisitions for outsourcing food and fodder production: In recent years particularly, cash-rich nations such as China (Mainland), Japan, Kuwait, Saudi Arabia and the Republic of Korea have engaged in buying or leasing huge quantities of foreign land for the production of food for domestic consumption. Their big corporations engaged in acquiring land in foreign countries are using their technical and financial power to increase the production of food, fodder and biofuel crops. With the supply of the world's food under long-term threat, investment in land is viewed favourably and is proving a sound proposition for many investors. For instance, the Republic of Korea's Daewoo Logistics recently announced that it had negotiated with the Government of Madagascar a 99-year lease of some 3.2 million acres of farmland. Daewoo plans to put about three quarters of it under maize, while the remainder will be used to produce palm oil - a key commodity for the global biofuels market. Daewoo's plan is to invest about USD 6 billion over the next 20 years to build the port facilities, roads, power plants and irrigation systems necessary to support its agribusiness in Madagascar. This is expected to create jobs for the country's unemployed.

46 IRIN, "SADC meal planning", 22 August, 2008 <http://www.irinnews.org/Report.aspx?ReportId=79946>.

47 IRIN, "East Africa: Budgets to ease food crisis", 13 June, 2008 <http://www.irinnews.org/report.aspx?ReportID=78738>.

Daewoo is reported to have leased the land for a price of around USD 12 per acre, which is only a fraction of the price of farmland in the corporation's home country.[48]

Between 2006 and 2008, some Japanese food corporations including Asahi, Itochu, Mitsubishi and Sumitomo leased and purchased hundreds of hectares of land in Africa, Brazil, Central Asia and China (Mainland) for organic food production. Japanese firms are reported to own 12 million ha of farmland abroad for the production of food and fodder crops. A Gulf Cooperation Council (GCC) committee has been constituted - with representatives from Bahrain, Jordan, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates - to scout for overseas land in return for investments. Land deals have already been struck with Cambodia, Indonesia, Laos, Myanmar, Pakistan, the Philippines, Thailand and Viet Nam in Asia; Georgia, Kazakhstan, Russian Federation, Turkey and Ukraine, in Central Asia/Europe, as well as Sudan and Uganda in Africa. Saudi Arabia is also planning to acquire 1.6 million hectares in Indonesia to produce rice for export back home. After the 2006-08 turbulence, there is a general recognition among Gulf countries that oil revenues cannot feed their populations.[49]

China (Mainland) has emerged as a major player in the land acquisition race. It was estimated that by the end of 2008, the country has signed some 30 land deals in different parts of the world, including Africa, Australia, Central Asia and the Philippines in recent years. China (Mainland) has also prepared an agricultural policy on outsourcing food production. Given its huge population, rapidly-disappearing farmland to industrial development and the shift of the farming population to cities, China (Mainland) is looking for cheap sources of food and fodder. India is also moving fast not to be outdone by its neighbour in terms of land acquisition. About 15 Indian companies, led by the public sector State Trading Corporation (STC), are in the process of leasing farmlands in Latin America (Brazil, Paraguay and Uruguay) mainly to cultivate soybean and oilseeds. Indian companies are also moving into Myanmar to undertake production of pulses and to buy palm oil plantations in Indonesia.[50]

All of these initiatives can be interpreted as attempts to circumvent normal international trade processes to secure procurement at cost of food and other agricultural commodities. This approach has some similarities with the one adopted by multinationals for decades and which was estimated to represent about 40 percent of world "traded" commodities in 2000 occurring outside of "normal" trade processes and that escape WTO regulations (Fernández & Maetz, 2000). While some of these arrangements include heavy investments leading to increased production and employment generation, they also carry the risk, unless they are properly regulated and negotiated, of having dramatic consequences on access to land by farmers and communities in developing countries and for the countries themselves in terms of lost income. For instance, farmland prices have soared in Brazil as a result of the rush for Brazilian land by foreign investors.[51] In countries with no functioning land market and proprietary rights, land deals are conducted between investors and politicians who can easily be bribed to ensure that rightful residents are evicted off their land by force. In Cambodia, as in Madagascar and many other African countries, the Government is granting land concessions

[48] African News Network, "Madagascar to be the breadbasket of Korea?", 24 November, 2008, <http://www.africanagricultureblog.com/2008/11/madagascar-to-be-breadbasket-of-south.html>.

[49] Grain Briefing, "Seized! The 2008 Land grab for food and financial security", October 2008, <http://www.grain.org/briefings_files/landgrab-2008-en.pdf>.

[50] Grain Briefing, "Seized! The 2008 Land grab for food and financial security", October 2008, link.

[51] African News Network, Food crisis spurs global land rush, 24 November, 2008, <http://www.africanagricultureblog.com/2008/11/uganda-increases-production-decreases.html?>.

to investors.[52] A large tract of land used by subsistence farmers could be taken away, and often without adequate compensation if the "land grab" continues unabated.

Similar arrangements have been adopted by some American and European companies that have leased land or sub-contracted small farmers in food-deficit countries such as Ethiopia, the Republic of Mozambique and the United Republic of Tanzania to grow biofuel crops. The benefit of such a shift has been questioned by Ethiopian farmers in Wollaytta district of Ethiopia who converted their plots from growing food to biofuel. The company (Global Energy Ethiopia, an American-Israeli subsidiary), which promised attractive payment, was unable to honour its promise and the farmers, with neither cash nor food, had to rely on relief from aid agencies. Declining oil prices in the aftermath of 2006-08 and the onset of a financial crisis have proven a commercial setback for the biofuel company.[53]

Distrust of the private sector

A large proportion of the measures applied have amounted to increased involvement of the public sector in food markets. Many governments have been forced to embrace greater levels of subsidies, export restrictions and price controls to ease the burden of high food prices. For many countries, this appears to represent policy reversal in an otherwise market-friendly policy orientation. Malaysia imposed a ceiling price on rice sold to consumers and raised the guaranteed minimum price (GMP) for rice growers.[54] Some governments, including India, Pakistan, the Philippines and Thailand have also enacted harsh penalties for hoarding grain.

Conclusions

This chapter has examined policy measures that were adopted by some 81 countries in Asia, Africa and Latin America and the Caribbean during the 2006-08 episode and has assessed their implications for food security and poverty alleviation.

Many of the countries responded to the food price surge through a spectrum of policies both at the market and household levels. Several food importing countries reduced import tariffs, while many producing countries limited, or even banned, exports in order to avoid food shortages and further price increases. A number of countries chose to intervene directly in the market by managing food reserves in order to stabilize domestic prices. Trade policies and direct market intervention attempt to reduce the cost of food and increase its availability for all, both poor and non-poor. Countries also resorted to micro-level interventions through targeted consumer and producer subsidies and safety nets aimed at supporting specific population groups who are vulnerable and most in need.

The sudden and unpredictable increases in many internationally-traded food commodity prices in 2006-08 caught governments by surprise and led to many short-term policy reactions that may have exacerbated the negative impacts of the price rises. On the basis that such interventions were in many cases deemed inappropriate, many have called for improved policy choices to prevent and/or manage sudden food price rises. Similar calls for improved

52 Asian Human Rights Commission, Cambodia: Official land grab in Cambodia mirrors situation across region, August 6, 2007 (http://www.ahrchk.net/ahrc-in-news/mainfile.php/2007ahrcinnews/1311/).

53 African News Network, "Struggling Ethiopian farmers regret opting for biofuel crops over food crops", 19 November, 2008 http://www.africanagricultureblog.com/2008/11/struggling-ethiopian-farmers-regret.html

54 China View, "Malaysia takes measures to keep price of rice down", 13 May, 2008 <http://news.xinhuanet.com/english/2008-05/13/content_8158823.ase>.

discipline of markets were made during almost all previous episodes of high prices, but were largely abandoned after the spikes abated, either because they were deemed too difficult to implement, they entailed too high fiscal costs or complacency set in when low prices ensued.

As economists question whether the 2006-08 high price event represents a structural change of world markets for food commodities, many wonder whether the change of policy orientation represents a paradigm shift and will be sustained in the future, or whether policies will revert to the pre-2006 orientation. Whatever the answer, the fact is that the 2006-08 turmoil raised fundamental policy questions that require further investigation. For instance, what is the most efficient agriculture and food security policy to be pursued by developing countries in the long term? Is it to minimize intervention in the food and agriculture sector and continue a liberalized policy orientation? Will pursuing the policies of prior decades put countries at risk of future crisis-type events that will entail high social and economic costs? Or is it acceptable to divert part of a country's wealth (and/or its development partners) to protect and subsidize food systems to enable them to avoid or face future crises with lower welfare costs?

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Chapter 11

International commodity agreements and their current relevance for grains price stabilization[1]

Christopher L. Gilbert[2]

This chapter examines the various international commodity agreements (ICAs) with economic provisions (price bands and stockholding or supply control obligations) that were established in the post Second World War period with the declared objective of stabilizing international commodity prices. The report asks what, if anything, can be learnt with the ICAs in the current context of high and volatile food prices.

A contributory factor that has been identified as possibly driving high grain prices since 2007 is the apparently low level of global grains stocks. The next section outlines the theory of the role of stocks in price determination for storable commodities, discusses the downward trend in global public and commercial inventories and food stocks over the most recent decades and attempts to relate stock levels to prices. After which, a discussion on the history and motivation of the ICAs with economic provisions for the different products is presented, including the instruments they employed, the reasons for their lapse or collapse and their successes and failures. The lessons of the ICAs for concerns relating to the current elevated levels of grains price volatility are then drawn, including stockholding measures that are currently receiving attention. Finally, the chapter concludes with implications to policy.

Commodity stocks

Commodity prices are variable because short-term production and consumption elasticities are low. Production responsiveness is low in agriculture because input decisions are made before new crop prices are known. These decisions depend on expected prices and not price realizations. Price outcomes are seldom so disastrous as to result in the crop being abandoned on the trees or in the ground. Short-term demand elasticities are low because the actual commodity price may not be large component of overall value of the final product (cocoa in chocolate, coffee beans in soluble coffee powder); and, for subsistence commodities, because there may be few alternative affordable products (potatoes in nineteenth-century Ireland).

[1] This is the abbreviated and revised version of a report prepared under contract to the OECD. It has benefited from comments from representatives of OECD member countries. I am also grateful to Garry Smith for comments on the initial draft. All errors are my responsibility and not those of OECD.

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Changes in commodity prices originate in shocks to demand and supply. It has generally been supposed that price volatility for food crops owes more to supply shocks while volatility for industrially consumed commodities is driven primarily by demand shocks. This judgement reflects low income elasticities of demand for food, implying that food consumption is less variable than the business cycle, and high usage intensity for industrial commodities in construction and investment, resulting in their consumption being more variable than the business cycle. However, because harvest outcomes are not strongly correlated across either continents or commodities, supply shocks are more important in explaining movements in the prices of individual food commodities than in aggregate food price indices where a degree of offsetting takes place through averaging (Gilbert, 2010).

The relationship between price and stocks

Low elasticities imply that small shocks to production can have a large price impact. However, the impact of shocks on commodity prices is moderated by stockholding. Low prices, caused either by positive supply shocks, negative demand shocks, or both of these, imply probable positive returns to stockholding. Consumption demand is therefore augmented by stock demand until such point as the expected return from holding stocks is equal to rate of interest on comparably risky investments. The fall in prices is moderated to the extent that excess supply is absorbed in stocks.

The same mechanism works for excess demand resulting from negative supply shocks or positive demand shocks. These result in destocking thereby augmenting supply. The catch is that destocking requires an inventory. Once stockout occurs, price is determined simply by equality of consumption demand and production. The non-negativity constraint on stocks implies that stockholding behaviour will be more effective in moderating downward than upward price movements. This leads to the observation that commodity price cycles will typically exhibit long flat bottoms punctuated by occasional sharp peaks.

There have been significant advances in understanding inventory-moderated commodity price cycles. Building on a paper by Williams (1936), Samuelson (1957) illustrated the effects of storage on grain prices. In a pioneering paper, Gustafson (1958), writing in the context of grains, characterized the amount of storage which will take place in a competitive world in which there is no government intervention. The Gustafson storage rule applies in a simple non-dynamic model of agricultural supply and demand with a single state variable - availability, defined as production plus lagged carryover. Deaton & Laroque (1992) obtained essentially the same result as a so-called rational expectations equilibrium. Williams & Wright (1991) used numerical methods to approximate this equilibrium in more complicated dynamic models.

It is a feature of these models that commodity stocks and the commodity price are jointly determined. It is neither the case that the price is determined by the current carryover nor the reverse. Instead, there is an equilibrium relationship between the price in the current crop year and the planned carryover to the following year. This relationship is inverse - if availability is low, there will be no carryover and the market clearing price will be high while if availability is high, stocks will be carried forward to the next year and the price will be low.

Empirically, commodity researchers focus on the relationship between the current price and the lagged carryover, that is the carryover (if any) from the previous to the present crop year. This relationship is also inverse, but, unlike that between the price and the current year's carryover, is also causal (the current priced cannot affect last year's storage decisions). However, the relationship need not be constant as the price depends on availability which is the sum of the lagged carryover plus the current (actual or expected) harvest. For these reasons, one should not necessarily expect to find a constant relationship between price and stock levels. This possible non-constancy applies also in more complicated models, such as those in which production depends on expected prices, where the lagged carryover and the current harvest may affect prices with different weights.

This is also true for other reasons. Markets are forward-looking and analysts focus considerable attention on forecasts, in particular those produced by the USDA, of end-crop-year carryover. Prices can therefore rise or fall through one crop year in anticipation of a respectively low or high end-year carryover. Furthermore, higher production levels would also reduce volatility both directly, by increasing food availability, and indirectly, by resulting in higher stock over the future.

The foregoing discussion has related entirely to so-called speculative stocks. Inventory may also be held as working stocks. The analogy is with the transactions and precautionary demands for money. Such stocks yield their owners, typically processing companies or merchants, a "convenience yield" which is measured by the amount they will pay to have immediate access to the commodity (Brennan & Schwartz, 1985). It seems likely that changes in industrial structure and practice, in particular the emergence of just-in-time delivery systems, may have reduced convenience yields and hence diminished this component of stock demand. If this is the case, the same commodity price will be consistent with a lower level of stocks today than was the case, say, a decade ago. In practice, therefore, it makes sense to relate price to stocks relative to a current estimate of "normal stocks".

Grains stocks are also held by governments for food security reasons. Globalization resulted in increased reliance on trade rather than national stockpiles. Movements in these governmental stocks can be large and have the potential to obscure the stock-price relationship.

Price volatility will also be related to lagged stock levels, but subject to the same qualifications. In the context of a high carryover from previous years, a negative supply shock (a poor harvest) will be met largely by destocking. The price impact will therefore be limited. In the case of a zero or low carryover, the same supply shock would require consumers to reduce consumption. Because demand elasticities are low, the price will need to rise by much more to clear the market. Volatility will therefore be negatively related to stocks (Gilbert & Morgan, 2010). But because volatility is directionless, both upward (poor harvest) and downward (abnormally good harvest) price movements will be larger when stocks are low than when they are high.

Storage Adequacy

Policies which result in higher levels of storage than would otherwise have been the case may be expected to reduce volatility. This raises the question of the adequacy of storage in the absence of public intervention. This question may be posed either at a global or a national level. In this section, I address the adequacy of global stocks from an economic theory perspective. The adequacy or otherwise of national grains stocks depends on the trade environment and on the objectives of national policy – I discuss this question in Chapter 18 of this volume.

Economists discuss the adequacy of global grain stocks in terms of whether private stockholding decisions will result in "optimal" outcomes. Optimality can fail to obtain if price volatility results in negative externalities or if those impacted by volatility are unable to offset the resulting uncertainty either through insurance, through hedging on futures or options markets or through other state-contingent contracts. The view that volatility gives rise to externalities (Gardner, 1979) is difficult to make rigorous – the dangers arising from food riots might be one possible route. Price risk is generally not insurable, since it is common across the entire range of producers, consumers and intermediaries, but it may be possible to offset these risks, either directly or indirectly, through hedging on organized exchanges where these exist. Supply chain intermediaries in developed economies, including those involved in physical storage, will routinely access these markets. Producers may benefit indirectly if these benefits are intermediated to them by, for example, purchase contracts which provide pricing fixing options. Governments might in principle operate in the same manner for consumers.

The extent to which global stocks are adequate can therefore not be separated from the question of the adequacy of risk-sharing arrangements. These arrangements will be least effective for those products where the markets themselves work least well. In the grains complex, this is most evidently the case with rice. For other grains, there is a choice between taking the state of risk sharing arrangements as given and focussing policy on augmenting storage, or, alternatively, of taking storage levels as adequate and focussing policy on improving the access to and the effectiveness of risk management.

If global grains storage is regarded as inadequate, governments might either attempt to augment private stocks by public food security storage programmes might provide incentives to the private sector to carry additional stocks. The public storage approach has the major disadvantage that it will discourage, and possibly eliminate, private storage – see below. Subsidization of private storage is therefore likely to be more attractive and financially less onerous. Williams & Wright (1991) found that subsidization of private storage was superior to public storage schemes.

Public and private stocks

Theories relating commodity prices to private stockholding behaviour have important implications for commodity policy. Miranda & Helmberger (1988) have shown how public stockholding, for instance by a buffer stock agency, changes the incentives for the private sector to hold stocks. In particular, the agency's commitment to purchase at the agreed floor price will pre-empt those private sector purchases which would have taken place in the event that the non-intervention price was below the floor price. At the same time, if the stabilization band (the gap between the ceiling and floor prices) is narrow, intervention will limit potential capital gains to private stockholding. If market conditions are sufficiently weak, the public sector may end up holding the entire market deficit. This was the situation under the sixth International Tin Agreement which collapsed in 1985 - see Anderson & Gilbert (1988). Clearly, floor provisions of this type make buffer stock stabilization extremely expensive.

The stabilization ceiling price can be vulnerable to speculative attack (Salant, 1983). If speculators perceive the stocks held by the stabilization agency as possibly insufficient to maintain the ceiling price in the future, they will compete to buy the entirety of the agency's remaining stock in order to take advantage of likely capital gains. Recognizing this, Williams & Wright (1991) suggested that, while a stabilization agency might choose to defend a price floor, price band schemes offer few, if any additional advantages. In particular, the apparent symmetry of the price band is only superficial since once the stock is exhausted, there is no means of defending the ceiling.

Speculators may also in principle attack a floor price by selling the commodity short. There is, however, an important asymmetry between a floor (short) and a ceiling (long) attack. Speculators will typically operate on the futures and not the cash market, at least in the first instance, as futures transactions only require the deposit of margin, typically 10 percent of contract value, while cash transactions require full payment. Futures therefore permit leverage. Futures purchases at or near the stabilization ceiling will pull cash prices up in line with the rising futures price as the contango (the difference between the futures and the cash price, if positive) must be equal to the carrying charge (interest plus warehousing and depreciation costs) - see Hull (2006). Upward pressure on futures price therefore translates dollar for dollar into the cash price which the authority is required to defend. This does not apply to speculative futures sales at the floor as the backwardation (the difference between the cash and the futures price, if positive) can be indefinitely large. Provided market participants believe that the authority has sufficient finance to defend the floor, it can allow the futures price to fall beneath this level. Furthermore, the authority is in a position to perform a "short squeeze" on the speculators by forcing them either to deliver the commodity at contract expiry or close out at a loss. For these reasons, short speculative attacks rarely occur whereas long attacks are more likely.

The risk of speculative attack arises out of the commitment to sell at a pre-announced price. It is irrelevant whether this ceiling price is a parameter of the intervention scheme of whether instead it is defined as a moving average of past prices. These considerations suggest that, if public storage is envisaged, the intervention agency should, following the implication of Williams & Wright (1991), refrain from committing to a ceiling price but should instead sell on an opportunistic basis if a shortage emerges. The absence of a ceiling commitment should not affect the extent of volatility reduction that is achieved since this will be determined by the quantity of stock available to be sold, not the price at which it is sold.

Trends in international grain stocks

In this section, I consider the evolution of stocks of wheat, maize (corn) and rice at the world level. It is necessary to exercise caution in the interpretation of these numbers as much of the stock data are inferred from data on production and consumption. I use data from the United States Department of Agriculture (USDA), in preference to data from the Food and Agriculture Organization of the United Nations (FAO) as the USDA data are available over a longer time period. The FAO data tend to imply higher stocks-consumption ratios but the general trends are the same in the two datasets.

Dawe (2009) argues for exclusion of Mainland China stocks on the basis that the country is largely self-sufficient in all three major grains and that Mainland China's production and consumption are not impacted by world prices. Furthermore, much of the variability in world grain stocks is the result of accumulation and disaccumulation on the part of China (Mainland). I therefore look at stock-consumption ratios both including and excluding China (Mainland).

Figure 11.1 shows the world wheat stock-consumption ratio from 1960/61 to 2009/10.[3] The figures move closely together except in the late 1990s when Mainland China accumulated large levels of stocks - 49 percent of the world total at the end of the 1998-99 crop year. Stock-consumption ratios have declined over the fifty year period considered from around 35 percent to around 25 percent. In real terms, the world wheat price has declined in real terms from around USD 250 per tonne to around USD 175 per tonne (in 2005 values)[4]

[3] Ratio of closing stocks to consumption on a crop year basis. Source: USDA.

[4] I deflate by the United States Producer Price Index, PPI (all items). The figure therefore measures the wheat price relative to the wholesale prices of all goods using United States weights. Although the precise numbers change, the general pattern shown in this and the following figures is unaffected by the choice of deflator. Data source for prices and PPI: IMF, International Financial Statistics.

Figure 11.1: Wheat stock-consumption ratio

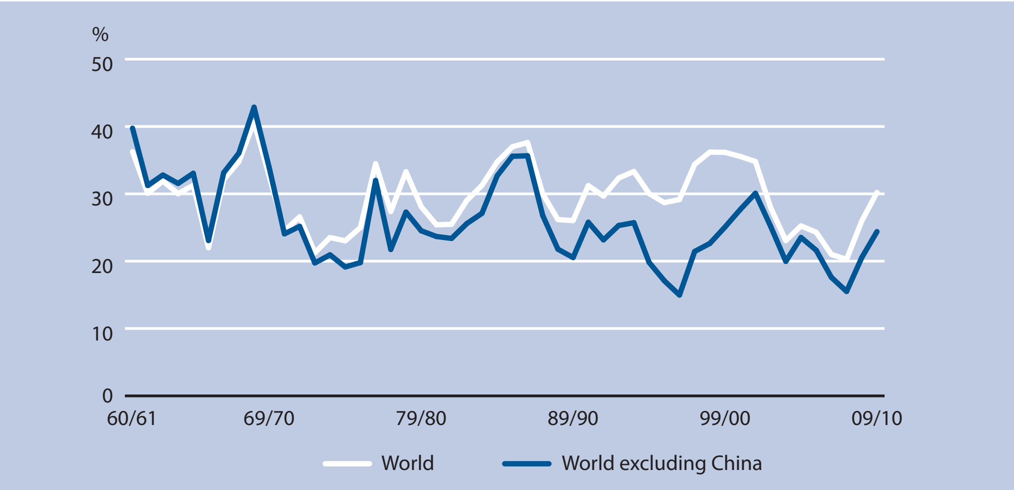
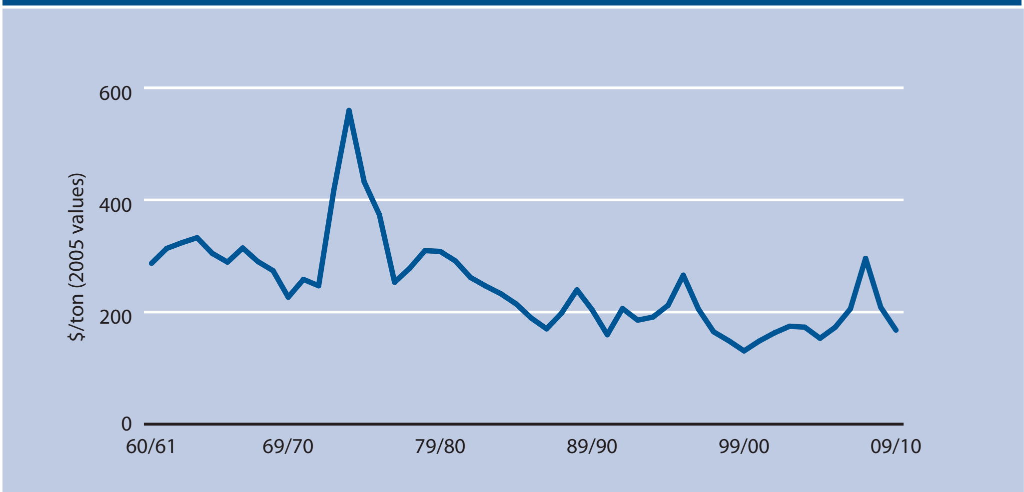


Figure 11.2: Wheat reference price deflated by United States PPI



- see Figure 11.2. The result is that the simple relationship between wheat stocks and prices has been obscured by increases in agricultural productivity, resulting in lower prices, and improvements in stock and production management resulting in lower inventory requirements.

Figures 11.3 and 11.4 provide the same information for maize. Stock-consumption ratios have declined even more dramatically in maize than in wheat - from a similar initial value in the early 1960s of around 35 percent to a current value of near 15 percent. While this decline was steady for wheat, in the case of maize there was a sharp jump back to the earlier levels in the late 1980s. Again as in wheat, Mainland China's stocks were very high in the late 1990s, accounting for 64 percent of world stocks from 1997/98 to 1999/2000. Over the same

Figure 11.3: Maize stock-consumption ratio

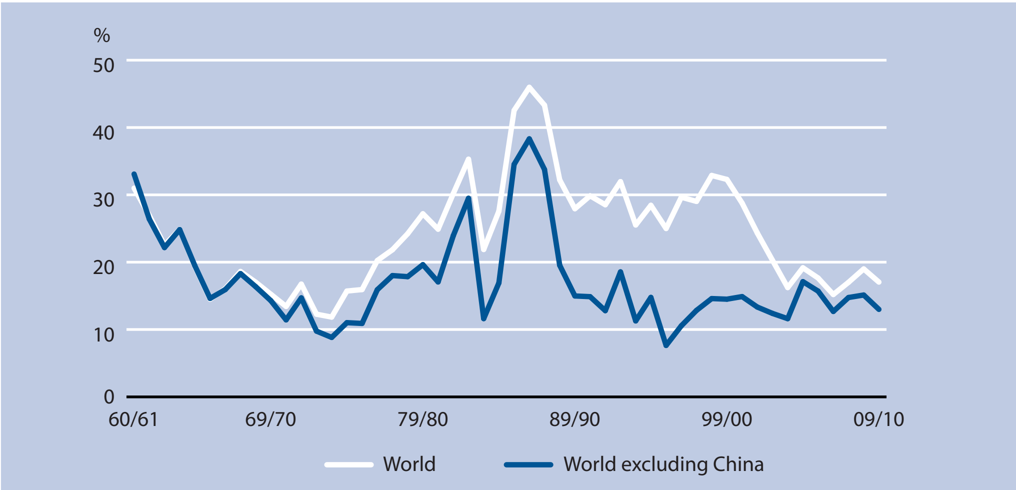
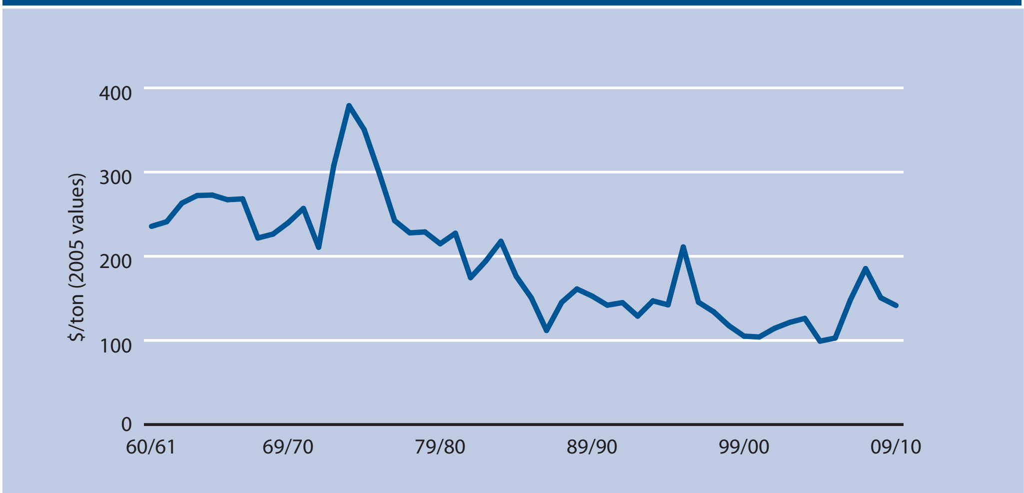


Figure 11.4: Maize reference price deflated by United States PPI



period, the real maize price has approximately halved from around USD 200 per tonne in 2005 values) in the early 1960s to around USD 125 per tonne through the 1990s. Even at its recent 2007/08 peak, real maize prices were substantially lower than in the 1970s and eighties.

Rice shows a starkly contrasting picture - see Figures 11.5 and 11.6. Here, stock-consumption ratios have tended to increase over time, from around 7 percent in the early 1960s to around 20 percent now. China (Mainland) accumulated enormous stocks in the late 1980s and early 1990s holding almost 75 percent of world stocks in 1990/91 and 1991/92. Aggregate non-China (Mainland) stocks have shown much lower variability. The Bangkok spot price is generally taken as an indicator or the world rice price. This halved in real terms from around USD 600 per tonne (at 2005 values) in the early 1960s to around USD 300 per

Figure 11.5: Rice stock-consumption ratio

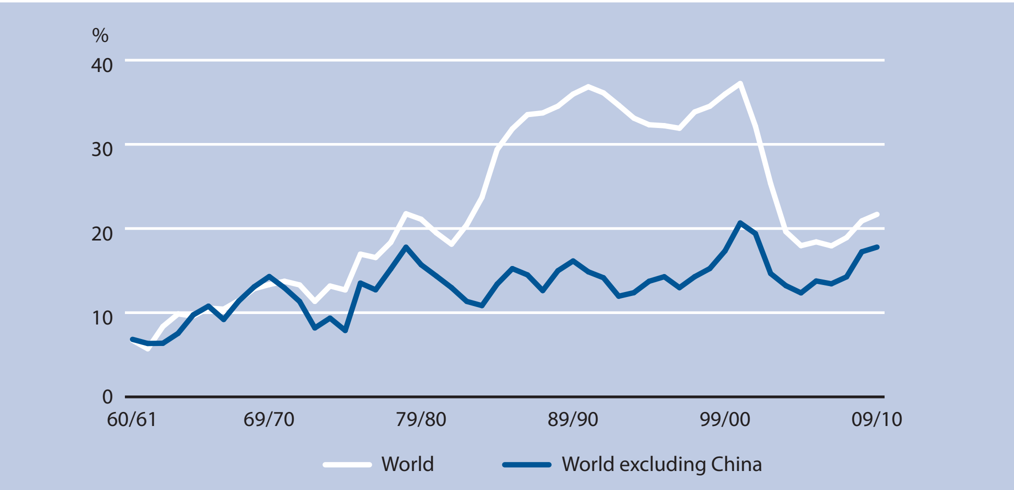
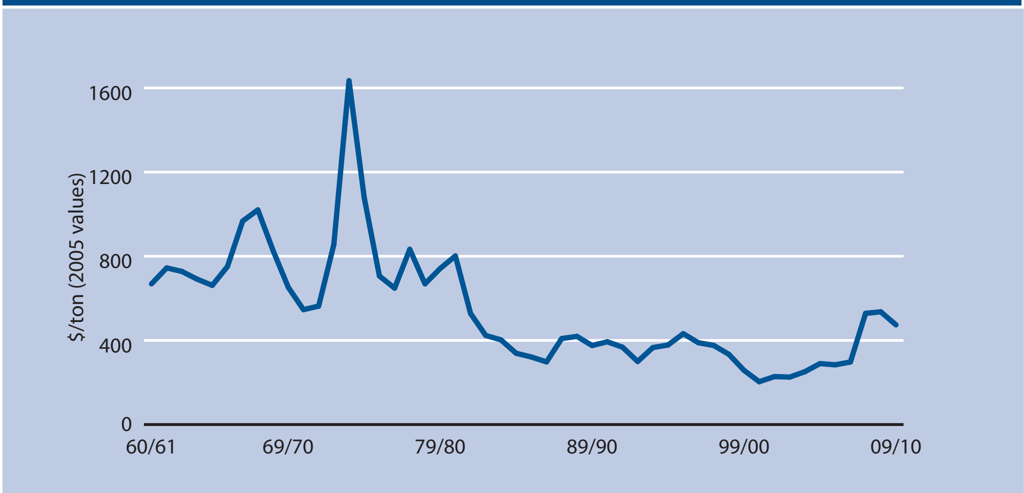


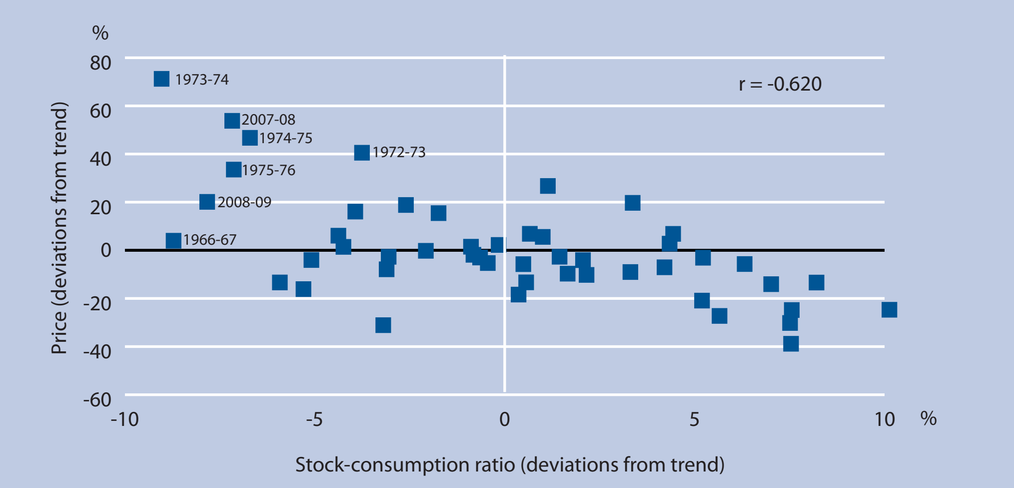
Figure 11.6: Rice reference price deflated by United States PPI



tonne prior to the 2006-08 spike. Even at its 2008 peak, the rice price was much lower than it had been in the 1970s. (It is important to note, however, that the free market in rice is residual and that actual transactions prices may differ markedly from the Bangkok quotations).

The general picture is one of trend declines in wheat and maize stock-consumption ratios taking place simultaneously with declines in real grains prices, although rice has seen rising stock-consumption ratios. Some part of the trend decline in these rations is attributable to change in developed country agricultural policies (Mitchell & Le Vallee, 2005). Overlaying this, there was a very substantial accumulation of grain reserves on the part of China (Mainland), starting with rice in the late 1980s and following through into wheat and maize in the 1990s followed by disaccumulation in the first five years of the new century.

Figure 11.7: Deflated wheat prices and stock-consumption ratio: 1961/62–2009/10



Taking a long-period view, the lower stock-consumption ratios in wheat and maize probably result from greater production and organizational efficiency in the food processing industry. The more general decline in stocks in all three grains over the most recent decade, by contrast, is the result of China (Mainland) destocking - see Dawe (2009).[5] Part of the argument as to whether world wheat and maize stocks are now too low therefore revolves round the issue as to whether Mainland China's stocks would, in the past, have been available to the world economy to provide a cushion in the event of a negative shock. A negative answer to this question would suggest that the decline in Mainland China's stocks may not be important in understanding recent and current high grains prices.

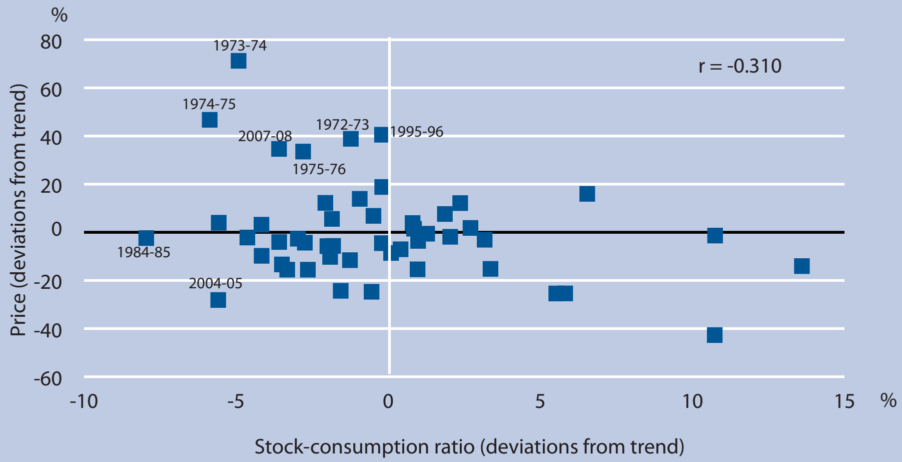
Grains stocks and grains prices

In order to see whether, and by how much, grains stocks have impacted grains prices it is necessary to disentangle the long-term trend movements in prices and stocks from the shorter term variations about trend. Econometric modelling offers one approach to this problem. An alternative is to use more straightforward statistical trend extraction methods. This is the approach I adopt here. It is important to emphasize that the results I report may be sensitive to the trend model adopted and the sample over which the trend is identified. Use of a long sample reduces problems associated with start and end points but makes the assumption of a constant linear trend less plausible. I therefore adopt the approach of fitting smooth trends but which nevertheless permit continuous variation in the slope of the trend - see Koopman et al. (2009).

Figure 11.7 illustrates the resulting relationship for wheat. The horizontal axis measures deviations of the world stock-consumption ratio (i.e. with Mainland China included) from its estimated trend, lagged one year. The vertical axis measures the deviation of the wheat

5 FAO (2004) concluded that "Much of the drawdown in world stocks has been due to a drawdown in Mainland China's cereal inventories". However, they also caution that it is difficult or even impossible to estimate the "true" level of cereal stocks in Mainland China in the past, and that apparent changes may have resulted from different estimation procedures or from statistical revisions.

Figure 11.8: Deflated maize prices and stock-consumption ratio: 1961/62–2009/10



price, deflated by the United States PPI, from its estimated trend. The correlation, negative as expected, is 0.620. If China (Mainland) is excluded from the stock-consumption ratio, the correlation falls to 0.500 indicating that the fall in Mainland China's stocks may have been a factor in rising wheat prices. The negative relationship is clear, but is dominated by the four observations from the 1970s price spike (1972/73, 1973/74, 1974/75 and 1975/76). The 2007/08 observation falls in the middle of this group. Nevertheless, the relationship is only modestly strong - stock differences explain less than 40 percent of price differences. Approximately the same stock deviation as 2006-08 was observed in four other years (1966/67, 1974/75, 1975/76 and 2008/09) but was associated with much lower price deviations from trend. Low stocks appear to provide only a partial explanation of high wheat prices.

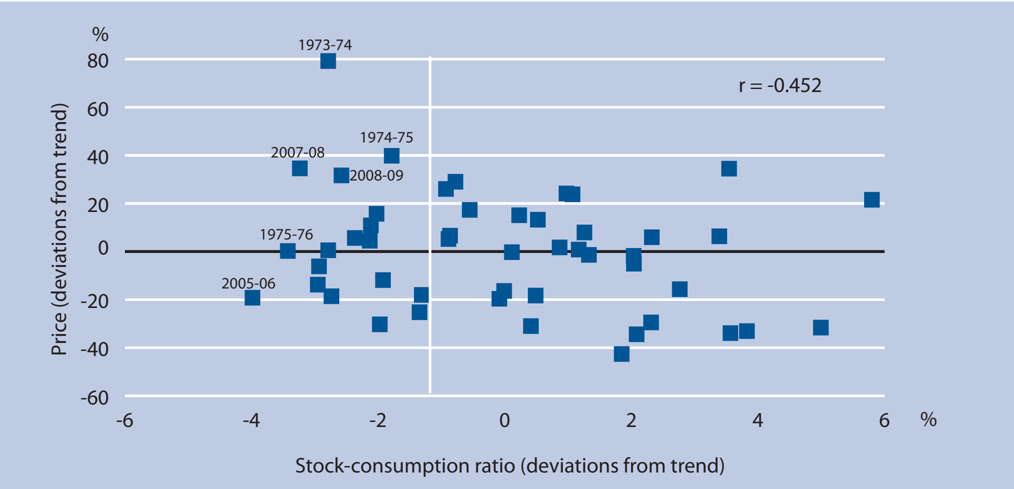
Figure 11.8 shows the corresponding relationship for maize. Here the correlation is lower at 0.310.[6] The 2007/08 observation gains falls within the range defined by the 1970s price spike. Although high price periods years are associated with low stocks, there are many years with similarly low starting stocks for which the price is close to (e.g. 1984/85) or below (e.g. 2004/05) its estimated trend. Low stocks therefore again appear necessary but not sufficient for high prices.

For rice, a superior correlation is obtained by excluding China (Mainland) from the stock-consumption ratio (0.452 against 0.223) supporting Dawe's (2009) argument. Figure 11.9 therefore shows the former relationship. The observations for 2007/08 and 2008/09 are comparable to those for 1974/75 but as in the case of maize, low stocks appear to be necessary but not sufficient for high prices.

Summarizing, by considering deviations of both the deflated price and the stock-consumption ratios from their respective trends, it is possible to discern the expected negative relationship between grains stocks and grains prices. Furthermore, the combination of the price and the stock-consumption level in 2007/08 was comparable for each of the three grains to those observed in the 1970s food price spike. Galtier (2009) implies that even if high food prices were not due, in the first instance, to falls in stocks, the low level of stocks will have

6 Excluding China (Mainland), the correlation is almost unchanged at 0.304.

Figure 11.9: Deflated rice prices and stock-consumption ratio: 1961/62–2009/10



amplified the magnitude of the price rises. Comparison of Figures 11.1 and 11.2 (wheat), 11.3 and 11.4 (maize) and 11.5 and 11.6 (rice) indicates that price spikes only occurred when the stock level was exceptionally low. However, low stocks did not necessarily lead to price surges. Low stocks appear therefore to have been necessary but not sufficient for high prices historically. This suggests both that changes in stock levels provide a partial explanation for the level of grains price and that the overall level of stocks is an important determinant of price volatility. Low stocks appear therefore to have been necessary but not sufficient for high prices historically. This suggests both that changes in stock levels provide only a partial explanation for the level of grains price but that the overall level of stocks is an important determinant of price volatility.

Dawe (2009) is therefore incorrect in arguing that "stocks did not have an important effect on the evolution of the world food crisis". However, the relevance of variations in estimates of Mainland China's grain stocks remains unclear. Other commentators have emphasized diversion of food commodities into use as biofuel feedstocks (Mitchell, 2008), exchange rate changes (Abbott et al., 2009) and futures market activity (Gilbert, 2010). Any evaluation of a stock-based policy to counter possible volatility should take these and other additional factors into account.

International commodity agreements[7]

The term "international commodity agreement" (henceforth ICA) refers to a treaty-agreement between governments of both producing and consuming countries to regulate the terms of international trade in a specified commodity. There have been six ICAs which have had "economic" (i.e. interventionist) clauses: the International Cocoa Agreements (ICCAs), the International Coffee Agreements (ICOAs), the International Natural Rubber Agreements (INRAs), the International Sugar Agreements (ISAs), the International Tin Agreements (ITAs) and the International Wheat Agreements (IWAs).

7 This section is partially based on Gilbert (2007).

There is also a large number of "study group" style agreements whose functions are information collection and dissemination, market promotion and, in certain cases, the fostering of research and development. With the ending of international commodity control, where they have survived, the previously active agreements have taken on this form. This function remains important and is not questioned by any comments on the "economic" clauses that follow.

Genesis and motivation

Primary commodity markets have been subjected to governmental intervention at least as far back as the 1930s. The first IWA was concluded in 1933 as a response to low wheat prices during the Great Depression. At the end of the Second World War, there was a widespread expectation across the range of primary markets that excess production and low prices and might return. The immediate post-war discussion of commodity matters aimed at avoidance of these outcomes. The unratified 1948 Havana Charter, which would have set up the International Trade Organization as the third pillar of Bretton Woods, included measures aimed at the alleviation of situations of "burdensome surplus" (Rowe, 1965). For the most part, it was envisaged that this would be accomplished primarily through supply regulation - typically export controls. In the absence of the institutional structures which the Havana Charter aimed to create, interested governments negotiated free-standing agreements of which the 1949 IWA and the 1954 ISA and ITA were the first. Both the ISA and the ITA focused primarily on supply management - the ISA entirely so, while the ITA also utilized a buffer stock, the initial purpose of which was seen as supporting the price over the period in which export restrictions took effect - see Fox (1974). These two agreements continued an interventionist tradition inherited from interwar colonial administrations. The 1949 IWA followed a different approach based on the concept of a multilateral contract (International Wheat Council, 1993).

Wheat and sugar are both produced in developed as well as developing economies. In the immediate postwar period, the major wheat exporters were Argentina, Australia, Canada and the United States of America. The ICAs subsequently negotiated from the 1960s related to tropical export commodities with the result that the exporters were developing countries and consumers were developed economies. This division coloured future developments.

At the time of the negotiation of the first ICOA in 1962, coffee was predominantly a Latin American commodity (Brazil and Colombia were the largest exporters), although production was already expanding in Africa. The Instituto Brasileiro do Cafe (IBC) was responsible for Brazil's coffee policy and had favoured supply management for many decades, but the Colombians had resisted this, preferring to expand production under unfettered conditions. However, as coffee consolidated in Colombia, the coffee-growing regions came to look for higher prices rather than increased output (Bates, 1997) . The ICOA was modelled on the ISA as a pure export control agreement. The United States of America was, and remains, the single largest coffee consuming nation. The crucial element which allowed the ICOA to come into existence was the willingness of the Government of the United States of America to agree to export controls. This was the period immediately following the socialist revolution in Cuba, and it is often supposed that the United States of America saw the advantage of higher coffee prices for Latin American exporters as outweighing the disadvantages arising from a controlled market. Bates (1997) argues that the highly concentrated United States of America coffee roasting industry was more concerned with reliability and security of supply than with price and may have seen acceptance of supply controls as a tolerable price for supply security.

Cocoa has largely been a West African crop throughout the post-Second World War period, although there is significant production for export in Southeast Asia. Latin America, which was important historically in cocoa, now produces largely for domestic consumption. Many of the West African cocoa producers are also coffee producers, and West African cocoa had inherited a tradition of state-controlled marketing from the British and French colonial administrations. In this context, it was natural that the cocoa producers would seek an agreement similar to that negotiated in coffee. However, the Government of the United States of America declined to join the 1972 ICCA, perhaps seeing West Africa as less important for United States of America interests than Latin America. The ICCA differed from the ICOA in that its primary instrument was the buffer stock, with export controls playing a supplementary role.

With the 1964 foundation of the United Nations Conference on Trade and Development (UNCTAD), ICAs moved into a more highly politicized environment. Existing ICAs came under the auspices of UNCTAD, which also sought, from 1976, to stimulate the negotiation of new agreements as part of the Integrated Programme for Commodities (IPC) in connection with the so-called New International Economic Order (NIEO). The NIEO was intended to set up what its proponents viewed as a more equitable system of trading relations between the developed and the developing world. The IPC was endorsed by the United Nations General Assembly in 1974. Its most explicit statement is in UNCTAD Resolution 93(IV) which sought the stabilization of commodity prices around levels which would be "remunerative and just to producers and equitable to consumers" (UNCTAD, 1976). UNCTAD produced a list of ten "core" commodities in which it hoped to see ICAs[8] but developed country governments argued for a commodity-by-commodity approach to negotiations. These negotiations took place in Geneva over the following years.

Brown (1980) gives an account of the UNCTAD negotiations. Although the rhetoric of the negotiations related to the variability of commodity prices, with buffer stock intervention now the favoured instrument, developed countries remained suspicious that the main intention of the producer country governments related to raising the level rather than reducing the variability of prices. The INRA was the only new agreement to emerge from this long process.

To summarize, the tropical export crop ICAs had emerged against a background in which colonial governments had historically regulated commerce and the subsequent UNCTAD push for more widespread agreements took place in a context in which many developing country governments hoped to re-establish political regulation of international markets. In sugar and wheat, the ICSAs were negotiated against a background in which international commerce had been largely on an intergovernmental basis. The initial motivation was the avoidance of excess supply and low prices and, in the case of wheat, food security. Subsequently, developing country governments pushed for "remunerative and just prices", a phrase widely interpreted by consumer country governments as suggesting above-market levels. Volatility reduction featured more prominently in the rhetoric of negotiation than in actual practice.

Export controls

The principal instruments used by ICAs have been supply management through export controls and buffer stock intervention. The ICOA and ISA both relied entirely on supply management while the INRA only used a buffer stock. The ICCA and ITA employed both

8 Cocoa, coffee, copper, cotton, jute, rubber, sisal (later extended to all hard fibres), sugar, tea and tin. Note the absence of grains.

instruments. In the first ITAs, the buffer stock was seen as a supplement to export controls but in later ITAs it assumed the major role. In the ICCA, the buffer stock was always more important than the export controls. The initial (1933) IWA was based on export controls but these were ineffective and absent from subsequent IWAs. Gilbert (1989) discusses the detailed intervention procedures.

Supply management presupposes the ability of government to control either production or exports. In agriculture, production is typically undertaken by a large number of relatively small producers, and the same was also true of most tin production. Governments can attempt to control production through quotas (livestock and dairy products), acreage controls (crops) or dredger capacity (alluvial metals) although yield variability can translate into substantial output variability for crop commodities. For export crops, governments have therefore found it more effective to control exports than production. In the cocoa, coffee and sugar agreements, these controls were often implemented through monopsony-monopoly marketing boards (a feature of many ex-British colonies) or caisses de stabilization (standard in many ex-French colonies). With exports constrained and little domestic consumption, export controls forced producing countries to accumulate excess production. When ICOA export controls were finally lifted in 1989, producer country inventories were released onto the world market resulting in depressed prices over the following five years (Gilbert, 1996).

To that extent, the difference between stabilization via export controls and via a buffer stock lies in who holds the stocks and at whose cost. In export control agreements, the incidence of the costs of stabilization is on producers and producer governments which have the incentive to reduce future production. Instead, with buffer stock stabilization, producer and producer governments have little incentive to reduce production. This is a major reason why the ICCA and ITA combined export controls with buffer stock intervention.

Export controls are better seen as an instrument for raising prices from unsustainably low levels than for stabilizing prices. This is because effective controls can compel reductions in available supply in the face of low prices, but can seldom compel producers to increase supply in the face of high prices. In a surplus situation, producers are collectively better off by collectively reducing exports from the levels which maximize profits on an individualistic basis, even if they would be worse off if they were to do this unilaterally.

Regulation through export controls faced three major problems:

1. Export controls rely on a comprehensive compliance both by actual and potential producers.
2. They may introduce distortions.
3. The potential benefits may be appropriated by or dissipated in rent-seeking activities.

With rigid historically-based quota allocations, these negative side-effects tended to increase over time.

Compliance is always a problem in any cartel-like arrangement. Each producer benefits from the price rise in resulting from other producers' supply restrictions, but would benefit himself by maintaining or even increasing his own production level (as price is now above marginal cost). Every producer therefore has an incentive to renege but is aware that obvious violations of the agreement will encourage others to follow. Because these agreements did not include any mechanism for redistributing profits between members, low cost producers, who might be inclined to expand even at low price levels, were often the least committed to controls. Because agreements only included countries who were significant producers at the time the agreements were negotiated, potential producers and producers who were too small to be included in the scheme, were unrestricted. Supply restrictions therefore tend to encourage both production by non-members and non-compliance by members. This was a serious problem in tin where Brazil, a non-member of the ITA, found it profitable to substantially expand production under the umbrella of ITC export controls. By contrast, high cost African coffee producers expanded market share at Brazil's expense under the umbrella of the ICOA. With the ending of ICOA controls, the Brazilian market share in coffee has returned to its pre-ICOA level.

The allocation of export quotas has the potential to distort both the production structure of the industry, as low cost member producers are unable to expand at the expense of high cost producers, and also the consumption structure, if more than one grade of the commodity is produced. Grade distortion was a major problem in the ICOAs, where consumer preferences moved during the eighties towards high quality mild arabica coffees at the expense of robustas and unwashed arabicas. The ICOA's historic quota allocations generated a significant premium for mild arabicas, while at the same time the agreement allowed production in excess of quota of these premium coffees to be sold at substantial discounts in non-member consuming countries, largely in eastern Europe and Southeast Asia - see Bohman & Jarvis (1990). This caused resentment in importing member countries.

As primary prices generally declined in real terms during the 1980s, the price raising features of the export control agreements became more apparent than previously, but at the same time, growing evidence that, at least in the case of coffee, quota allocations in many instances generated rent-seeking, cast doubt on whether the coffee growers themselves were always beneficiaries of these prices. The extent and effects of rent seeking behaviour of this form in the Indonesian coffee sector has been well documented by Bohman et al. (1996). It is difficult to gauge the extent to which the benefits from higher prices fed through to farmers were appropriated by supply chain intermediaries and others or were simply dissipated in wasteful activities. The net result of these activities was that the coffee producers came to see little direct benefit to themselves from the control agreement. This was a major cause of the 1989 lapse of coffee market intervention (Gilbert, 1996).

Rent seeking and market distortion are problems of market efficiency. The extent of inefficiency introduced by resort to export controls increases the longer they are in effect. Increasingly, therefore, the international community came to see attempts to formalize export control arrangements into long-term agreements as misguided.

Buffer stock stabilization

Buffer stock stabilization rests on an implicit premise that private sector storage is inadequate. This may be a valid assumption in the absence of efficient futures markets as individual risk aversion will in general result in investments (here investment in storage) requiring inappropriately large risk premia (Arrow & Lind, 1970). However, where they exist, futures markets allow separation of the speculative and storage decisions with the result that hedged stockholding becomes near riskless and so should be unaffected by individual risk aversion. In that case, it is invalid to claim that high volatility justifies public sector storage.[9] All three commodities for which buffer stock intervention was envisaged (cocoa, natural rubber and tin) were traded on futures markets. Among the grains, maize and wheat are actively

9 It remains the case that if futures markets are biased predictors of future cash prices, commodity storage may reflect incorrect incentives but at least in the case of agricultural crops, risk should be idiosyncratic and hence diversifiable which should result in unbiased futures prices. The empirical evidence is consistent with futures prices being near unbiased.

traded on futures exchanges but rice is not.[10] This suggests that while it is possible to make a theoretical case for public sector storage on the basis of inadequate private storage for rice, this is more difficult for other grains.

The foregoing considerations apply to international stockpiling. Additional factors may be relevant to national food security stocks, in particular in developing countries. High food prices are likely to impact particularly on the urban poor and on landless rural households. These groups will typically have few assets on which to fall back and will be vulnerable in that adverse shocks may have negative impacts with much longer duration than the shocks themselves. Co-insurance at the family or village level is ineffective for common shocks which impact the insurer as well as the insured. The private sector will not be motivated to purchase for the needs, as distinct from the likely purchases, of these vulnerable groups. Developed economies use targeted social and family support policies to protect vulnerable groups of this sort. Targeting is less important in developing economies where larger and often more homogeneous groups are vulnerable. In these cases, there may be arguments for either public food security stocks or variable tariffs (or export controls for an export crop) to ensure that domestic grains prices do not rise too far or too fast.

Staple foods form a large part of the budgets of poor households in most developing countries. This makes food prices and availability acutely political. Governments are therefore unable to credibly and effectively commit not to intervene in the event that a shortage arises. However, this fact makes it unattractive for private merchants to store grains until government has announced its decisions. In turn, governments justify intervention by reference to the unpreparedness of the private sector. These problems are largely absent in middle income and developed economies in which governments typically follow policies based on pre-announced intervention rules.

Finally, one might argue that volatility resulting from low stock levels will impose negative externalities (Galtier, 2009). The major impact of these externalities will typically be on supply chain intermediaries, in developing countries particularly acutely on locally-based intermediaries with limited access to credit and futures markets. The consequence is that such intermediaries will often operate at inefficiently small scale and will be at a competitive disadvantage relative to multinational competitors (Dana & Gilbert, 2008; Galtier, 2009). These concerns are legitimate but it is arguable that they may be better addressed by encouraging the growth or creation of local futures markets, where this is feasible (UNCTAD, 2009), or by provision of direct assistance to the intermediaries concerned.

At the practical level, international buffer stock stabilization faced three major problems:

1. The long-run price level about which stabilization should take place may change over time, requiring updating of the stabilization range.
2. Even if the stabilization range is appropriately defined, the intervention authority may lack the resources to keep the price within the range.
3. Once the buffer stock is exhausted, the intervention authority lacks instruments for dealing with any further price rise.

The long-run sustainable price may change over time because of changes in production costs, or of consumer tastes. Problems associated with updating of price support ranges became central in the three buffer stock ICAs. In the two decades to 1973, buoyant real prices in conjunction with low inflation in the developed countries implied that periodic

[10] Rice is traded on both the Bangkok and Chicago markets but volumes are thin and prices are not always representative of those relating to more important off-exchange transactions.

upward revision of ranges was required. This seldom proved controversial because, with actual prices generally above the stabilization range, consumer country governments did not see range revisions as likely to raise realized prices. By contrast, over the two decades from 1975, falling real prices and (after 1981) low inflation, prices tended to be at the bottom of the price range in buffer stock agreements. The ITA contained no mechanism for revision of the price support range, and this range also suffered from an implicit dollar link. The lack of updating procedures was an important factor in the collapse of the ITA (Anderson & Gilbert, 1988).

If, on the other hand, the stabilization range adjusts so rapidly that it simply tracks the market price, the agreement will not stabilize prices to any useful extent. Specifically, if an agreement stabilization range is revised down to a sufficiently large extent in relation to weak market conditions, producing countries will cease to perceive any interest in the so-called stabilization exercise. The INRA included provisions for periodic revision of the support range in relation to a moving average of past price. These revisions proved unpopular with producing governments since with weak prices, downward revision implied a fall in actual prices. Disputes over downward revision of the price support ranges were important in the eventual abandonment of intervention in the second INRA (Gilbert, 2007).

The second problem is that buffer stock stabilization can be expensive. This is obvious if "stabilization" is around a price in excess of the long-run market clearing level, but would also be true in a "neutral" scheme in which the correct long-run price level had been identified, supposing this to be possible. Theoretical models suggest that commodity price cycles should exhibit long flat bottoms punctuated by occasional sharp peaks. Buffer stock stabilization will consequently be an expensive instrument for dealing with low prices since stocks will need to be held over a long-period. These difficulties are exacerbated by the fact that public sector storage displaces private stocks. Townsend (1977) has shown that any neutral price-fixing scheme will eventually exhaust available resources. It is clear that the less finance an intervention authority has available, the earlier this likely exhaustion date. Lack of finance severely handicapped the ICCA and was a major cause of the collapse of the ITA.

Buffer stock stabilization was also ineffective at the peaks, which arise from stockouts - the third problem indicated above. Once the stock was exhausted, the authority was powerless to do anything except campaign for an upward revision of the support range.

In practice, the updating and finance difficulties tended to become entangled. Because of long investment lead times, metals and tree crop commodities can experience acute excess or (as presently) under-capacity for sufficiently long-periods of time as to make buffer stock stabilization about the supposed long-run price infeasible. This factor was important for both the ICCA, as the result of severe excess capacity during the 1980s, and in the ITA, where exhaustion of Malaysian alluvial deposits had resulted in a sustained period of under-capacity in the seventies. The ITA broke down because the agreement was inadequately financed, was attempting to stabilize at too high a level and was carrying the entire world surplus. The ICCAs were both poorly financed and committed to stabilizing the price at too high a level.

Multilateral contracting

The 1949 IWA was based on multilateral contracting. IWA exporting members guaranteed assured supplies of wheat subject to a maximum price while importing countries guaranteed purchases subject to a minimum price. These provisions were maintained in the 1953, 1956, 1959 and 1962 IWAs. These arrangements worked well so long as prices did not fall significantly beneath the IWA floor or exceed the ceiling but were difficult to sustain in more turbulent times. Contractual floor and ceiling prices were absent from IWAs after 1971 (International Wheat Council, 1993).

The IWA multilateral contracts were contracts between governments. This was natural at a time in which international trade in wheat was dominated by intergovernmental transactions and in which the prices paid to farmers in wheat exporting countries were set or heavily influenced by national farm support policies. Except in rice, grains commerce is now largely in the hands of private companies which contract on the basis of market prices. Governments would therefore currently need to enforce commitments of this sort through a regime of taxes and subsidies. However, WTO regulations require countries to reduce export subsidies thereby making it difficult for governments to guarantee agreed maximum prices. Even if it were judged desirable, the original IWA concept of multilateral contracting would therefore no longer be feasible.

Multilateral contracts are a form of forward contracting. The IWAs extended for three years, so the IWA multilateral contracts may be regarded as a set of one, two and three year forward contracts, for quantities which were not specified but implicitly related to past transactions, capped at predetermined floor and ceiling prices. These prices are negotiated to be fair to exporting and importing countries at the start of the agreement so at that time they have zero value to either side, i.e. neither exporters nor importers are financially better off as the result of the contracts (Hull, 2006). However, as market conditions change during the course of the agreement, the contracts have positive equity for one side and negative for the other - if prices rise, importers gain from the price ceiling at the expense of exporters while if they fall, exporters gain from the floor at the expense of importers. Once the losses from adherence to the negotiated ceiling prices become substantial, there is pressure from farmers to renegotiate or renege, as in the Commonwealth Sugar Agreement (also based on multilateral contracting) in 1973. If the losses from sticking to the negotiated floor prices become substantial, consumers and importing governments seek renegotiation, as the 1967 IWA a year after its negotiation.

Multilateral contracting can work well so long as price volatility remains low but lacks enforcement mechanisms and hence credibility when volatility becomes high. It is ill-adapted to a world in which commerce takes place between private companies.

Decline of the ICA movement

The commodities debate becoming increasingly politicized through the latter half of the 1970s and into the eighties. Many developed country governments viewed price stabilization as a costly diversion of funds from more pressing development objectives. Some suspected that a number of commodity exporting countries wished to substitute an inefficient socialist-style "planned" commodity economy which would result in an unfavourable shift in the terms-of-trade against the developed countries. Industry groups saw the continuing UNCTAD negotiations as driven by political rather than commercial concerns. Consequently, the ICA movement went into reverse.

- The ISAs had never managed to overcome the problems caused by the USA's 1962 decision to deny access to Cuba, then the largest sugar-exporting country, to the United States of America market, and by the substantial growth in sugar production in the European Union. The fourth ISA terminated in 1984 and was replaced by an agreement which did not contain market intervention clauses (Gilbert, 1987).

- The IWAs failed to achieve mechanisms for updating contractual price floors and ceilings in the face of market turbulence which commenced in 1968 and became acute in the 1970s. Implicit in this was the absence of incentives in the agreements to ensure continued adherence to the agreements in altered market circumstances.
- The ICCA allowed the possibility of market intervention through unspecified production management measures, but no longer through the buffer stock. However, the ICCAs never had either the finance or the country coverage to be able to have more than a small effect on the cocoa market (Gilbert, 1987, 1996).
- The ITA broke down spectacularly on United Nations Day (24 October) 1985 as the result of attempting to defend an unrealistic floor price with insufficient finance the - see Anderson & Gilbert (1988).
- The ICOA effectively abandoned supply management ambitions on (United States) Independence Day (4 July) 1989. In the post-Cold War period, the USA no longer saw a need to provide surreptitious financial support for its Latin American coffee-producing allies, and Brazil, now the second largest coffee consumer as well as the largest producer, had mixed motives.
- This INRA staggered on until 1999, a year prior to the formal ending of the third INRA, when first Malaysia and then Sri Lanka and Thailand gave notice of withdrawal from the agreement. These actions were in part motivated by the perception that, because of adjustment of the price bands, the INRA offered too little stabilization. This effectively terminated the agreement and hence also the ICA movement.

There is no single reason for the breakdown or lapse of the commodity agreements. The cocoa and sugar agreements lapsed because they were ineffective. The tin agreement collapsed because it was attempting to hold the price at too high a level with too little finance to do so. This was the single case which corresponds to the widespread view that ICAs attempt to stand "Canute-like" against the incoming market tide, but it is important also to recall that the ITA was effective for the first twenty-five years of its existence. More interesting are the cases of coffee and natural rubber where the agreements lapsed rather than collapsed. In the case of coffee, this was because the agreement lost support from consumers and to some extent also from producers (Gilbert, 1996). The case of rubber is more complicated and is relevant to some current policy discussions. The INRA provisions required that the stabilization band would be automatically updated in relation to a moving average of past prices. Nevertheless, updating remained controversial when this implied downward revision of the floor price (Gilbert, 1996). In the end, stabilization lapsed as producing country governments saw little benefit from continued price smoothing.

These changes in support took place in the context in which the markets for tropical export commodities were being liberalized and in which domestic stabilization agencies - marketing boards and caisses de stabilization – were being dismantled or forced to accept reduced powers - see Akiyama et al. (2001). The private sector was becoming more important and government involvement in agriculture was diminishing. Governments had both less power than previously to control supplies, and also a diminished willingness to attempt control. The ICAs appeared anachronistic and international meetings, in which diplomats deployed non-commercial arguments about price and export levels, seemed irrelevant in the face of the imperatives of competing in largely liberalized markets.

ICA effectiveness

The extent to which ICAs have (a) raised and (b) stabilized prices remains controversial. Evaluations have typically relied on counterfactual simulation of econometric models, for example Smith & Schink (1976) on tin and Palm & Vogelvang (1981) on coffee. Exercises of

Table 11.1: Post-ICA price changes

Year	Cocoa	Coffee	Natural rubber	Sugar	Tin	Average
- 1	100.0	100.0	100.0	100.0	100.0	100.0
0	65.8	63.5	102.8	59.0	55.5	69.4
1	55.7	67.3	92.6	55.3	50.5	64.3
2	62.0	61.8	110.9	80.6	44.9	72.0
3	63.4	55.3	150.0	80.2	57.7	81.2
4	60.7	77.9	167.5	101.6	44.5	89.4
Average 5-9	67.3	115.3	189.6	122.9	41.0	107.2

this sort are subject to qualification with regard to the extent that the models employed in the simulations adequately reflect market behaviour. These worries are underlined by the fact that production, stockholding and export decisions will adapt to the policies followed by the stabilization authority (Miranda & Helmberger, 1988). This adaptation is difficult to model.

Table 11.1 reports the results of a cruder evaluation procedure for the five ICA commodities for which developing countries are the most important exporters.[11] The table gives the annual price averages for cocoa, coffee, natural rubber, sugar and tin over the nine years following cessation of intervention. In each case, prices are measured relative to the IMF Commodity Price Index (non-fuel commodities), with the ratio normalized to 100 in the twelve month period prior intervention ceased or was abandoned. The indices in Table 11.1 should therefore be seen as indices relative to the general level of non-energy commodity prices. Except in the case of natural rubber, the ending of intervention was associated over the following two years with prices around 30 to 40 percent lower than in the final year of control. Despite subsequent recovery in coffee and sugar, on average prices remained 30 percent lower over the next three years, and much of this difference persisted over the following five years.

Post-ICA price changes

Taken at face value, the values in Table 11.1 suggest that ICAs raised commodity prices by a substantial amount. However, prices may have fallen for three other reasons:

1. Release of stocks either held by the buffer stock (tin) or by producers subject to export controls (coffee) will have depressed prices relative to their ICA levels.
2. ICAs may have lapsed or failed in the face of likely increases in supply. In coffee, the advent of Viet Nam as a major exporter in the early 1990s depressed prices after the ending of ICOA controls. It seems very unlikely that the rigid ICOA quota system would have been able to cope with the arrival of a major new exporter. Exporting members may have been aware of this possibility.
3. Other market developments may have resulted in prices being higher or lower than under ICA interventions.

Nevertheless, averaging over all five ICA commodities, it is evident that post-intervention prices were around 30 percent lower than might otherwise have been expected for two years

[11] Table 11.1 updates Table 2 of Gilbert (2007). Except for natural rubber, where an extended window is now available, differences relate to revisions in the IMF non-fuel commodity price index used as deflator. Data sources: IMF, International Financial Statistics except coffee, International Coffee Organization.

and around 10 percent lower for a further two years. This provides some evidence that the ICAs did raise prices.

Did the ICAs also stabilize prices? The answer to this question is complicated by the fact that commodity prices should be less variable when supply is plentiful - see Williams & Wright (1991), Deaton & Laroque (1992) and Brunetti & Gilbert (1995) - and the ending of controls tended increased availability through release of the buffer stock, or, in the case of export control agreements, by allowing exporting countries to sell accumulated inventory. Looking at the three year period immediately following the lapse or collapse of controls in relation to the three year period immediately preceding this, the coefficient of variation of monthly coffee prices fell from 23.6 percent to 10.7 percent, while the coefficients of variation for cocoa and tin rose from 6.9 percent to 14.3 percent and from 8.3 percent to 14.3 percent respectively. There is thus little clear evidence that the ending of ICA controls resulted in higher price variability. Coffee moved from a regime of high but volatile prices to one of stable depressed prices while the rise in the coefficients of variation for cocoa and tin is attributable to lower average prices - the price standard deviations are almost identical before and after the end of stabilization. Rubber price volatility reflected changes in market tightness - prices became less volatile in the weak market conditions at the time of the ending of the agreement but volatility has subsequently increased dramatically as the markets for all industrially-consumed raw materials have become very tight.

It is true of both export control and buffer stock agreements that they were more effective in defending floor than ceiling prices. In an export control agreement, it was always economically possible to limit exports although, as in OPEC, disagreement on the allocation of quotas may make this politically difficult. Quota allocation in the ICOA was very rigid and enforcement was undertaken by importing member countries who only accepted coffee certificated by the International Coffee Organization (ICO). When markets became tight, however, the ICO could do little more than exhort members to expand exports implicitly beyond commercially attractive levels. Similarly, in a buffer stock agreement, the buffer stock authority can buy the commodity so long as its funds are sufficient to do so,[12] while it can only sell what it has previously bought. Both types of intervention are therefore effective in preventing price falls than rises. But this is exactly the same as the situation of private stockholding in the absence of intervention.

Even if ICAs did generate benefits to exporting countries we should ask, "Who were the beneficiaries within the countries?" There is some evidence, particularly from the coffee agreements, that benefits were diverted to elites (Bohman et al., 1996). Export controls always create rents, partly because export quotas can be allocated to friends or political allies, and also because the administration of controls generates employment and therefore a vested interest in the continuation of controls. One reason Brazil lost interest in coffee market control was the perception that the major beneficiary was the controlling IBC bureaucracy (Gilbert, 1996).

Evaluation of the overall “success” of the ICAs is problematic on account of the confusion over their objectives. The rhetoric of the agreements, at least over the final decades of the century, stressed reduction in price variability, but here the effects appear to have been at best marginal. By contrast, producer governments have always seen ICAs as a means of raising prices, or at least of avoiding low prices, and on this criterion, the agreements - in particular the ICOA and the ITA - do appear to have enjoyed some success.

12 Perhaps longer than this - the eventual bankruptcy of the International Tin Organization arose because, essentially by means of the creative use of what would now be called off-balance sheet accounting, its market exposure greatly exceeded the resources it owned to purchase tin (see Anderson & Gilbert, 1988).

Summary

The motivation of the early post-War commodity agreements was the avoidance of excess supply and the associated low prices. Food security was an additional concern in the IWA. These agreements operated largely through supply management, principally export controls, although the IWA was built around multilateral contracting. The second round of agreements, which related to tropical export crop commodities, was justified in terms of price stabilization but was largely motivated by the wish on the part of the exporters to obtain higher prices. There was a significant shift of emphasis in these agreements towards buffer stock stabilization which had been seen in the earlier ITA as an adjunct to supply management.

Both export controls and multilateral contracting presuppose a substantial intergovernmental role in international commodity commerce. This was true of wheat in the initial postwar decades and was true of developing commodity exporters prior to the substantial market liberalization which took place on the 1980s. Both developed and developing country governments have now retreated from this level of involvement in commodity commerce and neither type of arrangement would now be practical. Furthermore, they are doubtfully WTO-compatible. Export controls had other negative impacts - they protected high cost producers from competition from lower cost competitors, they introduced distortions in the qualities (grades) available to the market and they induced significant rent-seeking behaviour. These negative impacts tended to accumulate with the duration of intervention.

Both export control and buffer stock agreements faced acute problems in updating their stabilization ranges over time. In the 1960s and seventies, inflation required that floor and ceiling prices be periodically raised. In the 1980s, altered market circumstances put downward pressure on the entire primary sector requiring stabilization objectives to be lowered. These changes were politically difficult and were a major factor behind the ending of intervention.

Buffer stock intervention was expensive, both because public storage crowds out private storage and because stabilization reduces the incentives for producers to expand or contract production. The costs of buffer stock stabilization could be reduced by periodic and formulaic revision of the stabilization range, on the basis for example of a moving average of past prices. This was the practice in the INRA. Nevertheless, it failed to diminish the extent of political controversy and limited the perceived usefulness of the agreement.

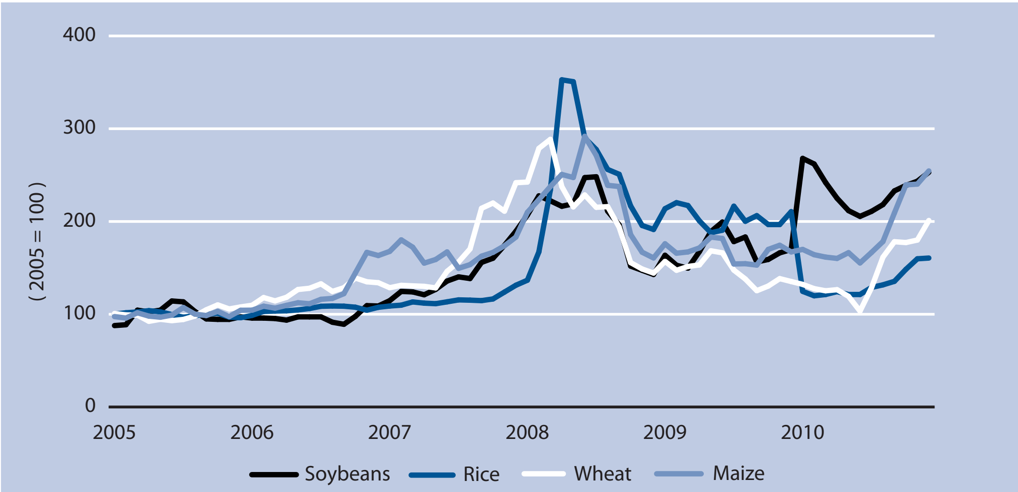
A review of the historical experience suggests that international commodity agreements were successful in raising prices but had little success in reducing priced variability. Part of the reason for this lack of success is that they lacked effective instruments for dealing with price spikes - countries cannot be forced to export beyond what is profitable and a buffer stock can only sell what it has previously bought.

The ITA was the only commodity agreement to collapse. In the other active agreements, intervention lapsed. It is incorrect, both as a matter of logic and history, to argue that commodity price stabilization is infeasible and is bound to break down. Instead, governments either lacked the will to continue to stabilize, or concluded that the benefits were too small or that the costs were too large to justify intervention.

Policy

The prices of grains and other food commodities increased dramatically in 2006-08. Subsequently, in 2009, prices fell back although, except for wheat, not to their pre-spike

Figure 11.10: International grains prices: 2005-10



levels - see Figure 11.10 which charts the world prices of the four principal grains, maize (corn), wheat, rice and soybeans.[13] The summer of 2010 witnessed catastrophic weather conditions in much of the northern hemisphere resulting in renewed upward pressure on the wheat and maize prices.

These developments have resulted in a widespread view that the combination of rapid economic growth in much of Asia with more variable weather conditions, perhaps in part caused by global warming, will result in higher and more variable food prices over at least the next decade. They have also provoked renewed interest in the possibility of international intervention to reduce or offset this anticipated volatility.

Lessons from the commodity agreements

The International Commodity Agreement (ICA) experience over the second half of the twentieth century is generally perceived as having been negative. The account given earlier this chapter indicates that this judgement is too simple. Except in a single case (tin), intervention lapsed rather than collapsed. Furthermore, it is necessary to ask what were the actual objectives of each agreement and whether they enjoyed the support and resources to achieve these objectives. Developing country exporters came to look at the ICAs as instruments for raising more than for stabilizing prices. The evidence suggests that the agreements may have been successful in this regard. By contrast, importing country governments laid emphasis on the potential volatility reductions that the ICAs were expected to deliver. These expectations were largely disappointed. The success or failure of the ICAs therefore depends to a large extent on the perceived intervention objectives.

The principal current concern in relation to the grains markets is volatility reduction and, in particular, the avoidance of further grains price spikes. Wheat remains the most important traded grain. Many wheat exporting countries are rich and few are very poor. By contrast, many of the poorest countries are grains importers. There is thus no suggestion that

13 Source: IMF, International Financial Statistics.

intervention should aim to raise wheat prices and there may be some hope that intervention might reduce the average level of prices over time. Food security issues have resurfaced.

Given these concerns, much of the post-1945 commodity agreement history is irrelevant. Limitation of exports will tend to raise rather than lower prices and does nothing to reduce either the incidence or magnitude of price spikes or to enhance food security. This leaves only the buffer stock features of the three agreements which used this instrument (cocoa, natural rubber and tin) as potentially informative for the current debate.

The discussions earlier highlighted four problems with buffer stock agreements;

1. They are potentially very costly, in part because public storage crowds out private storage.
2. There is a need to update the stabilization range in relation to changed market circumstances. This can result in controversy. Formulaic updating, on the basis for example of a moving average of past prices, reduces the potential for stabilization and hence the value of the intervention, but does offset the costs of intervention.
3. Given sufficient finance, a buffer stock authority can maintain a price above the agreed floor. However, the buffer stock can only sell what it has previously bought so once its stock is exhausted the authority has no further means of defending the ceiling. The consequence is that buffer stock agreements tend to more effective in limiting price falls than in curtailing the incidence and magnitude of spikes.
4. This feature is exacerbated by the possibility of speculative attack. Although attacks can take place either on a floor or a ceiling price, the problem is more serious at the ceiling.

In practice, it seems that there is little evidence that buffer stock stabilization did result in any significant reduction in price volatility. A possible objection is that the commodity agreements had mixed objectives and were thus not seriously committed to the reduction of price variability. This might be taken as implying that a new generation of price smoothing arrangements might be expected to enjoy greater success is reducing volatility. Nevertheless, the intervention authorities active in the commodity agreement movement would probably resent the suggestion that they were not fully committed to price stabilization and would be more inclined to blame the secular decline in real prices over the nineteen eighties and nineties for any lack of success. It is also debatable, and also untestable, whether more could have been achieved if the objectives of the agreements had been differently defined. In particular, the argument that price smoothing schemes based on moving averages of past price might be more effective than traditional schemes faces the problem that the natural rubber agreement, which had this structure, had little effect on volatility and lapsed because producing member countries failed to see value in the smoothing arrangements.

The substantive lessons from the ICA experience, where relevant to current circumstances, are therefore predominantly negative and are informative about what should be avoided and not what should be done. However, this does not imply that valid policy options are unavailable.

An international grains stockpile?

A number of commentators have proposed creation of an international grains stockpile. Most recently, Fan (2010) has argued that, as part of the five prong IFPRI programme, "the establishment of a global, coordinated physical grain reserve, which could be managed by the WFP".

There are two sets of arguments against this proposal - the first theoretical and the second practical. At a theoretical level, the proposal presupposes that private storage is inadequate. I discussed that argument earlier arguing that there is no generally valid theoretical argument to expect that, at the world level, private storage will be inadequate. Occasional price spikes would not themselves constitute such an argument since it may simply be too costly to eliminate them. Furthermore, even if it were thought that world grains stocks are too low there are strong arguments for preferring policies would stimulate additional private storage against those which emphasize public storage and which are likely to discourage private storage.

In the previous section it was argued that although it is possible to discern the expected stock-price relationship, this relationship is weak for grains. Low stocks appear to be necessary but not sufficient for price spikes. This is consistent with claims that many other factors have driven recent grains price movements. The possible counterfactual price effects of increased storage will depend on how higher storage interacts with these other factors. It may therefore be wise to discount the more optimistic claims made for an international grain stockpile which presuppose a much tighter stock-price relationship than that which is actually observed. At the very least, further work is required to quantify this nexus more precisely. These conclusions are in line with the theoretical discussion of the last section and are similar to those reached by Wright (2009).[14]

At a practical level, the commodity agreement experience makes it doubtful that intervention along these lines would reduce the incidence or magnitude of price spikes. Low stocks appear to be a necessary but not sufficient condition for high prices. It is arguable that a higher level of inventory would reduce market anxieties that supplies may prove insufficient, but it is also likely that the process of establishing an inventory in a period in which supplies are already tight will have an offsetting effect in increasing market concerns.

Buffer stock stabilization was costly and did not notably reduce price volatility for those commodities where it was employed. Much of the cost arises from the fact that public storage tends to displace private storage. In terms of the effectiveness of storage in reducing volatility, once the buffer stock is exhausted, it can do nothing to prevent further price rises. This, and the asymmetric risk of speculative attack at the price support ceiling, suggests that any intervention should forbear from committing to a pre-defined price ceiling, whether parametric or as a moving average of past prices. Instead, the intervention authority should follow the practice of many central banks which, when they intervene on foreign exchange markets, do so without prior announcement and without making their objectives explicit. This could substantially reduce the level of intervention costs by finessing both the updating and speculative attack problems.

Von Braun & Torero (2009) have advocated a virtual food reserve which would complement a smaller physical reserve. The virtual reserve, which would be backed up by a financial fund, would be used to "calm" markets under speculative situations, i.e. it would be used to countervail speculative pressure. The proposal supposes both that the fund managers know better than the market and that they can prevail against it. A precondition for any stabilization, whether physical or virtual, is greater transparency and certainty on grain production and inventories.

A useful analogy is with central banks which intervene in currency markets. The 1985 Plaza Agreement, which reversed the rise of the United States Dollar, shows that in certain circumstances well-planned interventions can be successful. Despite this, the profitability of many hedge funds comes from betting against central bank foreign exchange market interventions. The same would likely be true if a virtual grains reserve were to be established.

[14] Wright does suggest a small emergency reserve to respond quickly to national or regional emergencies which could help speed up responses of international organizations in relief situations (see Chapter 25).

Agenda for future research

The focus for future research should be on public grain stocks. The following issues appear salient:

1. It is widely held that grain stock levels have fallen sharply over the past decade. It was noted that this fall is largely owing to an apparent fall in Mainland China's stocks but that caution is required in interpretation of those figures. It would be very helpful if agencies could work with the Government of China to increase transparency on grains stock levels and to establish, with greater certainty and on a consistent basis, what stock levels were over the past decade.
2. Both economic theory and historical experience suggest that public stockholding crowds out private stockholding. This issue has received relatively little attention empirically. Is this effect large or small and does it vary according to the purpose and location of the stocks? It seems possible, for example, that emergency relief stocks may have little or no price impact while intervention stocks may have a large impact since the former will never be available to regular market participants. It is possible that the same is also true, perhaps to a lesser extent, of stocks held in developing countries and away from major international markets.
3. Additional research would be valuable on the potential cost and uptake of market instruments for hedging risks. Will these be feasible for all major grains or just for wheat and maize? In southern and eastern Africa, white maize is the principal staple. Can this be hedged on the regional South African (SAFEX) market, or should the Chicago yellow market be used, and, in that case, do white and yellow maize prices move sufficiently closely to make the instruments cost-effective? North African and Near Eastern countries are wheat importers. Do their prices move sufficiently closely with North American prices to make protection via Chicago calls effective, or should they hedge on the Paris market which although historically less liquid than Chicago, has becoming increasingly important as the European Union has moved away from direct support of prices?

It is the contention of this report that answers to these questions would lead to a more informed debate on international grains policy and that this is a prerequisite for improvements in policy.

Conclusions

The conclusions of this chapter are largely, but not completely, negative. International commodity agreements had multiple objectives. While it would be incorrect to claim that international commodity agreements failed, in general terms, they did not have significant success in reducing the volatility of the prices they set out to stabilize. By restricting exports, they probably did succeed in raising prices but this is not helpful in the current context in which the international community wishes to limit grains price variability, or at least limit its effects.

The focus of much recent discussion has been on the need for higher levels of grains stocks. Historically, low stocks appear therefore to have been necessary but not sufficient for price spikes. Stocks have fallen over time but this may simply reflect lower commercial inventory requirements. In any case, much of the fall in stocks over the past decade is the result of an apparent decline in poorly documented Mainland China's stocks from what were previously very high levels. The expected negative stock-price relationship is apparent in the data but stocks leave much of the variation in prices unexplained. It seems likely therefore that low stocks were only one of several factors which were responsible for the 2006-08 price spike.

Many commentators have reverted to public sector storage as a possible response to apparently inadequate private storage. Public storage crowds out private storage so the mere introduction of a public storage programme increases the problem that it was designed to solve. Public storage is therefore costly, and possibly very costly. Finally, it is unlikely to be very effective in countering price spikes since the storage authority can only sell what it has previously bought. The knowledge that it cannot counter price spikes will leave it vulnerable to speculative attack. The history of buffer stock storage in the international commodity movements bears out these views. If storage is seen as inadequate at the global level, it may be preferable to concentrate on measures which enhance rather than discourage private storage.

Finally, the chapter suggests an agenda for future research. This should focus on increasing the transparency of information on grains stocks, investigation of the extent to which different types of public storage impact private storage and examination of the costs and benefits from the use of market-based instruments.

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Chapter 12

The fallacy of price interventions: a note on price bands and managed tariffs

Brian Wright and Adam Prakash[1]

In the last century, a large variety of policy interventions have been used to address problems associated with price volatility in markets for storable commodities, notably grains. These include controls or sanctions on private "hoarding" or "speculation", buffer stocks, buffer funds, strategic reserves, use of options and futures, rationing of low-priced supplies, marketing boards, price floors, all of which obviously affect market incentives.

To interpret the asymmetric and episodic behaviour of grain market prices, and identify the causes of high volatility, it is crucial to understand the relation between prices, consumption and stocks (see Box 12.2). Accumulation of stocks when price is low can prevent steep price slumps. Disposal of these stocks when price is higher can smooth price spikes, but only if stocks are available. In a competitive market, short hedgers perform these functions, holding carryover stocks when the expected price covers the cost of storage and interest. Futures markets encourage short hedgers by facilitating the transfer of price risk to long hedgers (such as grain users) or long speculators, and protecting all participants from counterparty risk.

In the long view, recent grain price volatility is not anomalous. Wheat, rice and maize are highly substitutable in the global market for calories, and when aggregate stocks decline to minimal feasible levels, prices become highly sensitive to small shocks, consistent with storage models. In this decade stocks declined due to high income growth and biofuels mandates. To protect vulnerable consumers, countries intervened in storage markets and, if exporters, to limit trade access. Recognizing these realities, vulnerable countries are building strategic reserves. The associated expense and negative incentive effects can be controlled if reserves have quantitative targets related to consumption needs of the most vulnerable, with distribution to the latter only in severe emergencies. More ambitious plans to manipulate world prices via buffer stocks or naked short speculation have been proposed, to keep prices consistent with fundamentals. Past interventions of either kind have been expensive, ineffective, and generally short-lived.

The failure of commitment to uninterrupted market access among grain exporters (especially in the rice market) has also highlighted the desirability of commitment-reinforcing mechanisms for international grain market participants.

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Box 12.1: The economics of storage activity

To interpret the behaviour of grain market prices, and identify the causes of high volatility, it is crucial to understand the relation between prices and stocks. For the market to function effectively, a virtually irreducible minimum amount of grain must be held in the system to transport, market, and process grains. Though stocks data are notoriously imprecise, minimum working stocks are widely thought to be around close to 20 percent of use. A common feature of all such physical storage activity is that aggregate stocks are constrained to be non-negative. If current stocks are zero, it is impossible to "borrow from the future". To begin, assume that one crop is sown annually. The harvest in year t, h_t, is random, due to weather and other unpredictable disturbances. The effects of storage on consumption and price of grains, illustrated in the figure, is the result of the horizontal addition of two demands. One is the demand for consumption in the current period, c_t; the other is the demand for grain stocks in excess of essential working levels, x_t, to carry forward for later consumption. Consumption responds to price according to the downward-sloped function $P(c_t)$. Stocks x_t cannot be negative. To keep things simple, we ignore deterioration. In any period, regardless of the economic setting (monopoly, competition, state control of resource allocations) two accounting relations hold. The first defines available supply A_t is the sum of the harvest and stocks carried in from the previous year:

$$A_t = h_t + x_{t-1}$$

The second states that consumption is the difference between available supply and the stocks carried out:

$$c_t = A_t - x_t$$

Assuming competitive storage, stocks x_t are positive (in excess of minimal working stock levels) only if the expected returns cover costs (competition between storers prevents them from making greater profits). This means that the current price of a unit stored must be expected to rise at a rate that covers the cost of storage k and the interest charge at rate r on the value of the unit stored. Given available supply, A_t, storers carry stocks x_t from year t to year $t+1$ following a version of the age-old counsel to "buy low, sell high" represented by the competitive "arbitrage conditions":

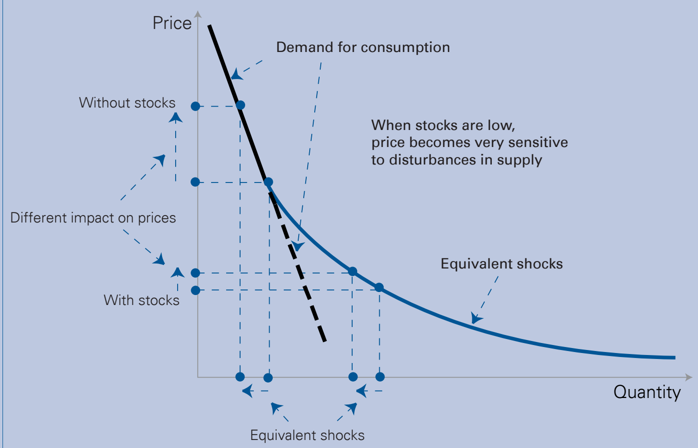
$$\begin{aligned} P(A_t - x_t) + k &= \tfrac{1}{1+r} E_t\left[P\left(x_t + \tilde{h}_{t+1} - \tilde{x}_{t+1}\right)\right], \qquad if \quad x_t > 0 \\ P(A_t - x_t) + k &\geq \tfrac{1}{1+r} E_t\left[P\left(x_t + \tilde{h}_{t+1} - \tilde{x}_{t+1}\right)\right], \qquad if \quad x_t = 0 \end{aligned}$$

where E_t denotes the expectation conditional on information available in year t, and $\tilde{h}$ and $\tilde{x}$ are random variables. As shown in the figure, when price is high and stocks (excluding essential minimal levels) are zero, the market demand is the same as the consumption demand.

Those who consume grains such as rice, wheat, or maize as their staple foods are willing to give up other expenditures (including health and education) to continue to eat their grain, so the consumption demand is very steep and unresponsive to price ("inelastic"); large changes in price are needed if consumption must adjust to the full impact of a supply shock unmoderated by adjustment in stocks. In 1972-74, for example, a reduction in world wheat production of less than 2 percent at a time when stocks were almost negligible caused the annual price to more than double. The figure also shows how, when stocks are clearly above minimum working stocks, storage demand, added horizontally to consumption demand, makes market demand much more elastic (less steeply sloped) at a given price. The responsiveness of this aggregate consumption demand to price is difficult to estimate, for several reasons. One is that, in empirical demand studies at the level of the individual consumer, it is difficult to distinguish consumption from storage (including stocks held by consumers) as prices fluctuate, and when the two get confounded the estimated response overstates the consumption response.

Secondly, at the aggregate level, years with high prices and negligible stocks above working levels are too rare to establish, by themselves, the steepness of the consumption demand.

Figure 12.1 How stocks moderate price response to shocks



Estimation of the dynamic storage model enables us to use data from all available years in determining consumption demand. However, the storage model has been difficult to implement empirically. One major hurdle is, again, the lack of reliable stock (or consumption) data (in recognition of this, grain statistics refer to "disappearance" rather than consumption). Work that pioneered the econometric estimation of this model in the 1990s, assuming no supply response, finessed the data problem by estimating the model on prices alone (see Deaton & Laroque, 1992; Deaton & Laroque, 1995; and Deaton & Laroque, 1996).

Recent application of a model in this tradition to prices of a set of commodities suggests that aggregate food-consumption demand responds very little to changes in the price of major commodities; the slope of the consumption demand curve for major grains may be even steeper than previously believed (see Chapter 15). To compensate for the low price response of consumption, more of the commodity is stored and stocks run out less frequently. The storage implied by the model smoothes prices, replicating the kind of price behaviour observed for major commodities.

By acquiring stocks when consumption is rising and price is falling, storers can reduce the dispersion of price and prevent steeper price slumps. Disposal of stocks when supplies become scarcer reduces the severity of price spikes. If the supply of speculative capital is sufficient, storage can eliminate negative price spikes but can smooth positive spikes only as long as stocks are available. When stocks run out, aggregate use must match a virtually fixed supply in the short run. Less grain goes to feed animals and the poorest consumers reduce their calorie consumption, incurring the costs of malnutrition, hunger or even death.

Storage induces positive correlation in prices and is least effective when harvests are positively correlated; storage cannot eliminate price changes caused by persistent shifts in demand such as the recent subsidized surge in biofuel production. Note also that the storage demand shown in the figure would shift up, pulling total demand with it, if the supply variance rose or interest costs fell.

If producers can respond to incentives with a one-year lag, that response is highly stabilizing for consumption and price. Their competitive adjustments of planned production increase the effectiveness of adjustments of stocks in smoothing consumption and price. When supplies are large, for example, returns are low and producers cut back production in response to lower returns and hold more stocks.

One such mechanism, discussed in the previous chapter - an "international coordinated global food reserve" - is included as the second part of the proposal by the International Food Policy Research Institute (IFPRI)[2]. The proposal is sketched as an agreement by members of a "Club" including members of the G8+5, plus major grain exporters such as Argentina, Thailand and Viet Nam. The members would commit to holding specified amounts of public reserves in addition to the reserves held by the private sector. These would be used to intervene in the spot market as directed by a "high level technical commission" appointed by the Club on a permanent basis, with full decision-making authority. Operation of this reserve is to be coordinated with operation of a virtual reserve, the third element of the proposal of IFPRI.

The interventions of the international reserve and the virtual reserve are apparently designed to execute a dynamic price band system operated by a "global intelligence unit" which also makes market forecasts and determines when markets are not functioning well. This unit would be part of an institution that "already has the long-and medium-term modeling infrastructure for price forecasting."

One difficulty in assessing this proposal is its lack of clarity in defining the problem it is meant to solve. Apparently these include "excess price surges caused by hoarding and speculation", restoring confidence in the market, preventing ad hoc trade policy interventions, and allowing the market to guide resource allocation in response to fundamental changes in supply, demand and production costs. A win-win solution is anticipated for producers and consumers, exporters and importers.

In assessing a price-band proposal and other market problems and interventions to be addressed, it is helpful to keep the following points in mind:

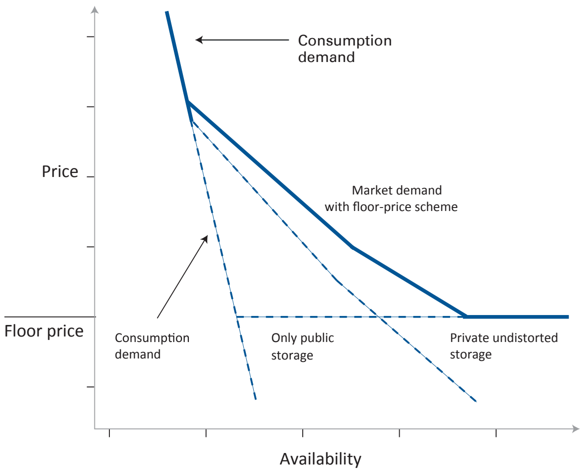
1. Any activity or policy that does not change consumption in a market does not affect prices in that market. On the other hand, if a policy decreases price, it increases consumption and decreases stocks. If planned production is responsive, it also decreases when the price drops.
2. Unless they address the fundamental source of disturbance (for example, disease, war, or weather), "stabilization" policies must actually destabilize some key variables (stocks or public budgets, for example) as they stabilize others (such as price).
3. There is no evidence that any chosen group of experts, no matter how well qualified and motivated, can reliably determine when a competitive market is acting in a way not justified by fundamentals. Indeed, the evidence against the general proposition that designated experts can outperform the market in forecasting or trading has grown overwhelmingly in the last several decades. Certainly the major international organizations concerned with food markets for the poor have no record of demonstrating such performance and wisely make no assertions of the capacity to do so.
4. In any intervention, net efficiency gains to the society as a whole are typically dwarfed by redistribution of gains and losses between producers and consumers. Those who most enthusiastically and effectively support storage interventions naturally tend to be the ones who are expected to gain from those policies. To comprehend these distributional effects, it is necessary to recognize the dynamic nature of the problem and also the importance of private responses to public actions.

A simple public floor price programme

Policy-makers find price-band policies appealing because they seem simple and easy to explain. The claim that the band keeps prices stable and concentrated around the centre of the band is intuitively appealing. Unfortunately, it is also misleading. To see why, it is best

2 See von Braun et al. (2009) and von Braun & Torero (2009).

Figure 12.2: The effect of a price floor on market demand



to consider first a simpler version consisting of a price floor at which the manager makes an open offer to buy or, subject to availability, to sell any amount of the grain in question.

Consider, for example, the announcement and introduction of a public floor price programme in a market with no short or long run production response and a random harvest. If the initial price is below the floor price p^F, the immediate effect is to increase price and stocks, draw down government funds, and reduce consumption. If the initial price is above p^F, and no private storage is allowed, the effects of introduction of the floor price p^F on storage, price, government funds and consumption are delayed until a there is a harvest large enough to push price below p^F if it were all consumed.[3] In the long run there is a significant probability that price is at the floor. Whenever the programme holds has stocks, the price stays at the floor, but when stocks are exhausted the price rises above the floor, and subsequently it reflects the outcome of the most recent harvest.

If, on the other hand, there is competitive private storage, and price is not too far above p^F, the introduction of the price floor raises the price higher immediately and reduces consumption, as the existence of the floor raises the expected price and encourages more private storage, increasing total demand, as illustrated in Figure 12.2. Government expenditure is delayed, however, until the price falls to p^F, and remaining stocks are sold out to the government.

In each of the above cases, the earliest non-zero effects of the price floor scheme on commodity price must be positive, as the first public purchases must precede the first public sales. This means that producer revenues are increased by the early effects of the programme as stocks are accumulated. The effects will be reversed later, when stocks are released, but the time value of money means the earlier gains to producers tend to dominate the later losses.[4] If land is priced to reflect the profits that it can produce, land price jumps when the programme is introduced, even if the effects on commodity price are delayed.

3 If there is supply response, then consumption and price, but not government revenue, are affected before the floor price is reached.

4 To see this, consider that the early gains could be invested and earn interest before they are balanced by equal dollar outflows. (See Wright, 1979 and Williams & Wright, 1991 for more on distributional effects of market stabilization.)

If private inventory holders are allowed to co-exist with the public programme, the floor is less frequently in effect, so in this sense the price is less stable. But such price variation, when it occurs, is dampened by the action of private speculators, and in this sense the market is more stable, and public and private stocks are complements in stabilizing the market.[5]

Price band buffer stock programmes

The floor price scheme described above is pedagogically useful for its simplicity. International agreements involving commodities including rubber, cocoa and tin have often combined the floor price with a higher "ceiling" or "release" price, a plausible way to protect consumers from the most extreme effects of price spikes. One consistent policy prescription in the history of economic advice on commodity markets has been that prices should be stabilized in a symmetric band around the mean, bounded by the floor and ceiling prices, to reduce the "boom and bust" gyrations typical of commodity prices (Keynes, 1982 and Newbery & Stiglitz, 1982).

A strong intuition is that such a programme keeps price around the middle of the "price band" most of the time, if the band is judiciously chosen. But numerical examples show this is not true.[6]

As illustrated in the Figure 12.3, for a programme with a floor that is 87.5 percent of the mean price of USD 100, and a ceiling set at 112.5 percent, there is a probability of about 15 percent that price is at the floor, and the probability that price is at the ceiling is almost 30 percent. There is little probability that price is between the mid-point of the band and the top. Most of the time, the market appears to be "challenging" either the floor or the release price.

The price ceiling discourages production and storage when available supplies are scarce, increasing price volatility as price approaches the ceiling. Are consumers willing to submit to a high probability of price at the ceiling, in exchange for reduction in frequency of greater food emergencies that may occur less than once in a generation?

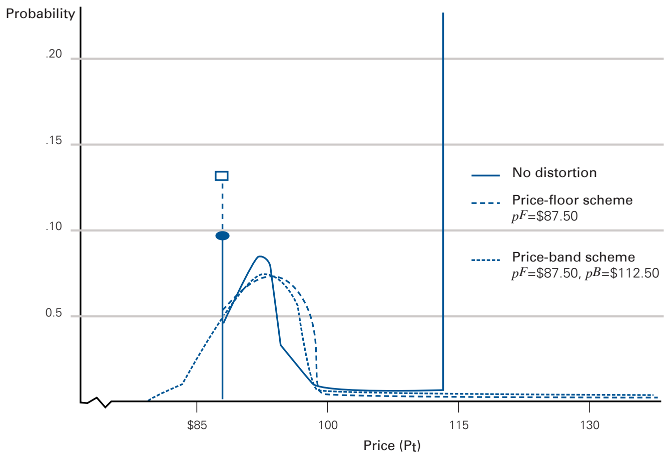
Another serious consideration is whether the sacrifice in terms of more frequent high-price years will be repaid with smoothing of extreme peaks when they occur. When a programme chooses a price floor p^F no higher than the free-market mean (adjusted for a perfectly-estimated trend if necessary), or chooses a price band where the mean of a floor and ceiling price equals the free-market mean, the programme has commonly been assumed to be "self-liquidating," that is, financially sustainable based on the fact that expected net balances should equal zero, and on the intuition that the summed funds from purchases and sales after several years of operation should be close to their initial value. But this intuition is wide of the mark, even for a simple floor price scheme.[7]

5 From the programme administrator's perspective, private speculators are the culprits in sporadic "speculative attacks" on the public stockpile: they acquire the whole stock when the price rises above the floor, and dump their stocks on the government programme when the price reverts to the floor. These actions may be viewed as "destabilizing" the stockpile, but they reduce large changes in price and consumption. (See Williams & Wright, 1991, Chapter 13.)

6 There are important interactions between bandwidth, private storage within the band, supply response, the expected rate of accumulation of losses, and the maximum level of stocks. See Williams & Wright (1991, Chapter 14).

7 To see this, consider the simple case in which demand is linear and planned production is constant, so the mean price is exogenous. Assume further that the harvest has a symmetric two-point distribution, there is no private storage, and p^F is set at mean price, the price when consumption equals mean production. Imagine

Figure 12.3: Price probabilities under a price floor and a price band

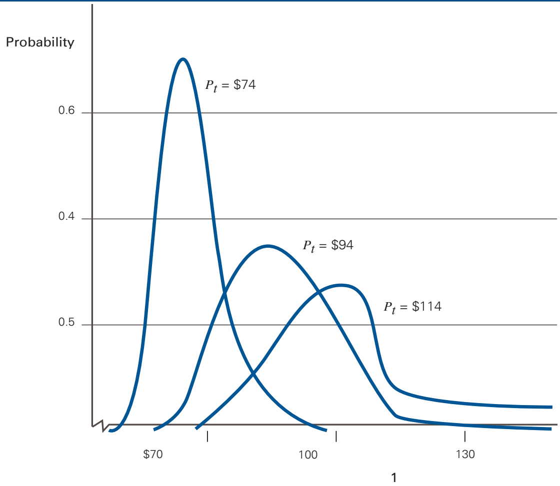


After several decades of operation (less than the interval between the last two extreme price spikes) the likelihood of a balance close to zero becomes vanishingly small. The fund may accumulate great profits along the way, appearing to affirm managers' skill and inducing pressure to raise the floor. Even if such pressures are resisted, the balance will deplete any operating reserve in finite time. In practice, post-war experience has affirmed that the "finite time" within which we expect such programmes to fail is disconcertingly short, often less than a decade. Recent failures in programmes for tin and wool (Bardsley, 1994; Gilbert, 1996; Haszler, 1988), among others, have shown that the largest and most catastrophic price effect of these interventions is the severe price collapse that accompanies their inevitable failure.

When such price support programmes do fail there is generally a public consensus that the intervention price was wrongly set, and management is often blamed for faulty trend forecasting. There is scant recognition that failure is inevitable at any relevant intervention price. Higher floor prices merely hasten its occurrence, and price band programmes tend to fail much faster because they tend to accumulate stocks at a faster rate. One way to try to avoid such failure might be to modify a price floor rule so the floor is adjusted down somewhat after one or two years of low price. This will enhance sustainability by reducing accumulation of debt. Figure 12.4 shows three probability densities of prices conditional on current prices respectively 74 percent, 94 percent and 114 percent of the mean, generated by a numerical model of competitive storage. If price is 94 percent of the mean, there is virtually no chance it will be below 70 percent of the mean next year. If the price does fall to 70 percent of the mean, there is virtually no chance it will fall below 60 percent next year. The market is acting like a floor price programme with floor price adjusting for recent experience, to prevent excess losses.

a "buffer fund" scheme whereby the government pays $p^F - p_t$ for each unit sold at each time t. Negative payments are receipts by the government. The fund's monetary balance, B_t, with initial value B_0, follows a random walk. Given an infinite horizon, the balance passes any finite negative bound in finite time, and the probability that it is zero at any future date is the same as the probability that it is never zero before that date, and quickly becomes negligible (see Feller, 1967, Lemma 1, p. 76). Similarly, a price floor backed by a buffer

Figure 12.4: Probability of price in period $t+1$ when current price P_t is 74 percent, 94 percent or 114 percent of the mean price, US Dollar 100



Note also that if price is 114 percent of the mean, the figure indicates a much larger chance of a lower than a higher price next year. There is a modest right tail indicating the probability of a price least 14 percent above the mean, but the model is acting much like an imperfectly effective price band programme with a ceiling at 114 percent of mean price.

Price band schemes, in theory, are bound to fail if the bands are not adjusted to reduce losses. In practice, failure comes fairly quickly. If, on the other hand, bands are adjusted to reduce accumulation of losses, the programme tends to mimic what the free market can provide. Price band schemes have been found wanting in theory and practice, and should not be tried again.

Using banded tariff regimes to manage global price volatility

In the 2006-08 episode, variable import tariffs were often employed by food-importing developing countries as a policy instrument, principally over the short term, to shield households from global food market volatility. As with all forms of price intervention, the challenge was and is to administer the level of tariff that allows price transmission in the long run from international markets to domestic markets which does not hinder the private sector's incentive to participate in international trade (World Bank, 2005).

Prior to the 2006-08 episode, variable tariff regimes were instituted in several Low-Income Food Deficit countries (LIFDCs) to mitigate the impacts of large falls in international prices, as applied tariffs could be raised up to bound commitments under the Uruguay Round Agreement on Agriculture (URAA).

Variable tariffs are also at the heart of "price band schemes". Price bands are a restricted form of variable levies, with the important distinction that they are not linked to a domestic support price (Valdes & Foster, 2003). They establish price floors and ceilings on import prices as a function of international reference prices.

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stock generates a fund balance that hits zero with probability one in finite time (that is, "infinitely often"). If a price ceiling is added, the expected time is to a zero balance is shorter.

Box 12.2: Price band schemes and international trade rules

Price bands and their variants are used in Colombia, Ecuador, Peru and other countries, but Chile was the initiator of the price band model observed today. Although not exactly the same as standard variable levies, price bands themselves, however, are suspect. The 2002 WTO ruling in the case of Argentina's complaint against the Chilean price band for wheat products and edible oils held that the band mechanism was similar to a variable levy and a minimum import price, both of which were held in violation of the URAA. Interestingly, the price band led Chile occasionally to exceed its WTO-committed bound rates of 31.5 percent, but this complication was sidestepped when, after initiation of the complaint, Chile modified its price band formula so that any resulting tariff (regular plus price band surcharge) would not exceed the bound tariff level.

The WTO Appellate Body ruled that, although the price band is based on world prices, it "can still have the effect of impeding the transmission of international price developments to the domestic market." Although this transmission-impeding character of variable levies was the most questioned aspect, it was the combination of the transmission argument with the lack of transparency of the price band mechanism that was in violation: "[N]o one feature is determinative of whether a specific measure creates non transparent and unpredictable market access conditions. Nor does any particular feature of Chile's price band system, on its own, have the effect of disconnecting Chile's market from international price developments in a way that insulates Chile's market from the transmission of international prices, and prevents enhanced market access for imports of certain agricultural products."

In fact, Chile's price bands were originally designed to be very transparent, without changes in the determination of the external reference price. Under the original scheme, predictability would have been eliminated as a concern. But the question of price transmission is different, being inherent to the variable levy nature of any price floor scheme (whether or not it includes price ceilings). Furthermore, the ruling was unrelated to the country's generally low level of protection.

Source: Valdes & Foster (2003).

Under such schemes, when the import price falls below the floor, surcharges are applied, and when the price exceeds the ceiling, importers receive a tariff rebate up to the applied tariff.[8]

Price band schemes have been in operation for several decades in a few Latin American countries. However, they have raised questions over their legality under the WTO rules, as well as over their efficiency and transparency (see Box 12.2).

But under what range should tariffs be managed? Several possibilities for setting floor prices are often proposed: moving average and other trends, base-period average prices and a minimum average cost of the world's "most efficient exporter". The unsystematic nature of a base period price, despite its simplicity, does not incorporate long-term trends, and in the absence of updating, would divorce producer responses from long-run changes in international prices. With permanency in price shocks (i.e. non-stationarity or long-memory, see Chapter 2), historic moving averages and trends would incorporate long-run information but do not guarantee that future prices will stay on the historic trend. In addition, the smaller the order of the trend, the more sensitive would the trend to sharp price disturbances, which ultimately does not instil long-run price efficiency in domestic production. Finally, the proposal that the floor price should be set on the basis on the cost of production schedule of the "most efficient exporting country" is admirable in lessening the risks of stimulating

8 When applied tariffs are low, price bands have notably asymmetric effects on producers and consumers because surcharges are limited by the bound tariff (perhaps high) and rebates are limited by a low applied tariff.

domestic production among inefficient farmers, but at the same time raises the question of objectivity and arbitrariness in ascertaining lead-efficiency prices.

Conclusions

Attempts to manage volatility through price controls are proven theoretically and empirically to be less than optimal. Use of price band rules to operate international or domestic market stabilization schemes is less simple than often assumed and less effective in ensuring food security for those most at risk. The price tends to hover at or near the upper or lower band, private storage is reduced or eliminated, and production is discouraged just when it is most needed. Theory predicts, and experience confirms, that these programmes inevitably fail even if there is no underlying trend in price. Moreover, the historical tendency to intervene in the price system in a discretionary and less-than-transparent way undermines private sector planning and opens programmes to capture by vested interests.

The use of variable tariff instruments is also subject to similar criticism. While at face value they present scope to protect producers from extremely low prices in food-importing countries, they require very open and transparent rules that would preferably be monitored by the WTO to prevent abuse and political patronage. Unless the tariff is already high, variable tariffs do not address effects of price spikes on consumers, and because high tariffs on food grains can cause both inefficiency and higher inequality (the poor are penalized), they are not usually a desirable option: it is clear that variable tariffs are of limited value for protecting against price spikes, a goal that is often the main concern of food-importing countries (World Bank, 2005). In addition, for those schemes that are in place, such as in Chile, comprehensive welfare analyses to establish the economic costs and gains have not been forthcoming.

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Part III

INFORMATION, EXPECTATIONS AND THE ROLE OF STOCKS IN GENERATING VOLATILITY

Chapter 13

The rise of commodity speculation: from villainous to venerable

Ann Berg[1]

Throughout history, food profiteering has been roundly condemned. Those engaging in speculation, hoarding or exploitation, or otherwise extracting money from sustenance have met with sharp rebuke, punishment or even execution. Until now. During the twenty-first century the once maligned food profiteer – particularly the commodity speculator – has been transformed into a generally positive and welcome force. Far from causing harm or havoc, the modern commodity speculator is often hailed as the new oracle of the food cycle, boldly wagering multi-million dollar bets on the direction of prices on mammoth futures exchanges. While pouring unprecedented amounts of money into trading commodities, speculators claim they are merely aiding what futures markets are meant to do – discovering the equilibrium price of goods at any moment in time. By providing "liquidity", they deliver a societal good and, citing numerous supportive economic studies, they maintain that their trading activities have negligible impacts on global benchmark prices or affect the food security policies of nearly every commodity dependent country. In short, unlike speculators of the past, they have managed to raise themselves to a respected professional class, shielded to some extent from ethical inquiry.

Background

Food security and statehood have gone hand in hand since ancient times. As far back as the fifth dynasty (2350 BC approximately), the rulers of Egypt took control of grain management; by the reign of Ptolemy I in 306 BC, they held ownership of supply, land and granaries, dictating that "all [grain] prices were fixed by fiat"(Levy, 1967). The *Code of Hammurabi*, the inscribed Babylonian tablets, determined exact wages for labour and services to be paid in per annum amounts of grain. The ancient city state of Athens, highly dependent on grain imports ranging from Sicily to the Black Sea, regulated every aspect of the grain trade including a ban on exports, the lawful port of entry (Piraeus[2]), maritime loans, inventories, prices and import taxes. In 386 BC, a group of Athenian grain merchants was tried for the capital crime of "hoarding and collusion". Early on in its Republic, Rome adopted *frumentariae leges* to control the supply and price of grain to its citizens.

1 Former director and trader at the Chicago Board of Trade and FAO consultant.
2 Importation to any port city other than Piraeus was a capital offense.

Similarly, Asia linked political control to food. During the Han Dynasty (202 BC - 270 AD), Chinese officials received half their salaries in grain. The collection and pricing of grain was extensively monitored and prices fixed during the first millennium BC under an official system during the Zhou Dynasty. In fourth century BC India, the *Arthasastra or* "handbook for princes" instructed that only proper authorities should undertake grain collection and that profit margins charged by merchants be strictly capped.

Starting in the first millennium, references appear in religious texts on food speculation. The Christian movement of Monasticism decried the "making of profits" over wheat in Syria. Talmudic law, compiled from approximately 70 AD to 500 AD forbid "fruit hoarding" and the hoarding of other food essentials such as oil, wine and flour, particularly with the intention of reselling these products at an exorbitant mark-up.[3] From its beginning in the seventh century, Islam forbade speculative activity (*gharar*) as one of its principles. According to the eleventh century Arab Islamic theologian Al-Ghazzali:

> *If a person hoards foods, then how can the needy reach it? [...] This is a grave sin. As for grains, the sin is for those who intentionally hoard to sell at a higher price later [...].* (Ghazzali & Field, 1991)

Similarly, in his *Summa Theologica*, St. Thomas of Aquinas condemns the "buying of goods in the market with the intention to resell them at a higher price."

The monetary revolution

The western feudal land-based system that had hindered the development of commercial markets disintegrated slowly starting in the thirteenth century For centuries prior, fragmented political authority, a dearth of metallic coinage, irregular and variable minting and the widespread practice of "clipping" or "shaving" led to the reliance on barter or even peppercorns and lengths of *Frisian* cloth as means of exchange (Bloch, 1967). The minting of gold practically ceased in medieval Europe between ninth century and thirteenth century even while the East maintained a gold standard. The gold solidus, or the bezant, was standard issue in Byzantium from the fourth century onwards and likewise the gold dinar[4] in the Arabian Caliphate from the late seventh century This foreign gold coinage did, however, circulate in Europe - the bezant finds increasing mention after the trade treaties established between the city state of Venice and Constantinople in the late eleventh century. The dinar facilitated trade between Southern Europe and the increasingly complex Islamic world.

While the Middle East[5] and China - during the Song Dynasty - established the recognizable components of banking - deposits, loans and letters of credit over long distance, the European system remained weak. Based on a multiplicity of silver coinages such as derniers, sous or later livres, contracts or loans were understood to be settled in equivalents of goods or labour, because of the ever present risk of non-payment of specie (Bloch, 1967). Although the Crusades precipitated monetary innovation (such as the Knights of Templar's check writing system that allowed the deposit if goods in Europe to serve as collateral against money drawn in the Jerusalem) crucially, medieval society never invented the banknote; paper money was circulating since the ninth century in China, a wonder recorded by Marco Polo (Venice) around 1295 and Ibn Battuta (Tangier) a few decades later.

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3 For a discussion of hoarding and Judaic law see: http://luc.edu/law/activities/publications/clrdocs/vol19issue2/keith_sharfman.pdf.

4 The gold dinar lasted for 13 centuries until the outbreak of World War I.

5 For a description of economic conditions in tenth-century Islam, see ttp://www.international.ucla.edu/cms/files/kuran.0130.pdf.

Fibonacci's *Liber Abaci*, written in Pisa in 1202 AD, reveals the growing scholarship and mathematical approach to commercial transactions, as well as the spread of Islamic scientific inquiry into southern Europe. *Liber Abaci* offers a compendium of tools for calculating present value, compounding interest, evaluating geometric series, dividing profits from business ventures and pricing goods and monies involving complex varieties of weights, measures and currencies.

When the balance of trade began to improve between southern Europe and its Eastern trading partners, more gold came into circulation. In 1252, Genoa and Florence[6] began minting their own coins and in 1284, Venice followed with the ducat.[7] Under Europe's new bi-metal system in the 13th century – silver coins served as domestic money and gold, with its higher store of value, became the international medium (Bloch, 1967). Indeed, the economy itself was roughly divided between the interior of Europe that was loosely populated by rural communities and townships and the outer ring of cities that engaged in shipping. The Hanseatic League founded in the twelfth century, which had its own legal system and defence policy against piracy, formed as a international alliance of trading oligarchs that hailed from a number of North Sea and Baltic towns (Polanyi, 1957).

The increased commerce propelled the development of banking, first in Venice in 1177 and later in other Italian and French trading centres, giving rise to *bills of exchange* - the forerunners of banknotes. Grain financing - begun in thirteenth century Italy by Lombard merchant banks - was arguably the first organized speculative trade in forward grain pricing and debt trading since Athenian times.

As the moneyed economy replaced the medieval system, financial innovation grew. In 1262, Venice issued the *Ligatio pecuniae* - a decree that formalized the paying of interest at 5 percent to lenders of capital and consolidated previous debt issuance. This innovation led to further developments in the financial markets: "government credits were traded in a secondary market and financial derivatives, such as overdue interest - became diffused objects of trade" (Pezzolo, 2005). The system marked the beginning of modern public finance and a sophisticated credit market based on government loans (Pezzolo, 2005).

Trade, risk and moneyed credit played crucially in the development of risk management mechanisms and speculative activity emerging during sixteenth century. In 1531, an exchange for the purpose of conducting commercial and financial transactions opened in Antwerp. Validated by Hapsburg emperor Charles V, a legislative framework regarding contract making and litigation was put in place within the same decade.

Shortly thereafter, as the principal market for Baltic grain, Amsterdam established a forward trade in grain that included transactions in cargo shipments or inventories stored in other ports. The exchange quoted daily the prices of wheat and rye. In addition, Amsterdam merchants developed a contract known as *stellage*, which was a forward contract with an option by the buyer to annul the contract for a paid premium. Other instruments - resembling modern options on futures - such as rights to buy or sell quantities at a specific price at a certain time - developed at the same time (Gelderblom & Jonker, 2005). During poor harvests, prices naturally rose, causing Amsterdam's sheriff in 1556 to accuse German and Flemish merchants of a "great evil." Following several official bans on forwards issued in 1556, 1565 and 1571, forward contracting continued, but was hampered by a government "keen to guard against the manipulation of the trade in staple foods such as grain, fearing the social unrest which might follow price increases" (Gelderblom & Jonker, 2005). *Windhandel* - or trading in the wind - came to be the Dutch expression denouncing speculation.

6 The florin.

7 The ducat would become the dominant regional gold coin for the next several centuries.

In England, statutes prohibited grain speculation as early as 1552. The statutory offenses were based on three common law violations: (1) forestalling–the purchase of grain outside of a market and a subsequent sale in the market; (2) regrating–the purchase and resale of grain in the same or nearby market; and (3) engrossing-the purchase of grain before harvest for the purpose of reselling after harvest (Banner, 1998). The law's prohibition of food speculation thus rested on a solid base of popular disapproval. Popular belief held that ″speculation raised prices, harmed the poor [. . .] exacerbated shortages [. . .] gave rise to deceit, and more subtly undermined the common good" (Banner, 1998).

Mercantilism in Europe

Capital markets obtained a major impetus with the creation of the first joint stock corporations in the early 1600s. By allowing the pooling of capital, these new structures revolutionized commerce and investment opportunities. Differing significantly from modern counterparts - as charters of the crown - they received monopoly powers for particular areas of commerce enabling them to become colossal enterprises. The Dutch East Indies Corporation, for example, would eventually tower in the seas with a fleet of 150 battle and merchant ships and a labour force of 50 000. This financial innovation - mutual ownership - did not aid futures markets development in commodities. Rather, the joint stock company was an extension of mercantilism, a system aimed at promoting exports and limiting imports through tariffs and the Navigation Acts.

In fact, the mercantile system was highly protectionist. In Amsterdam, increasing taxes and tariffs levied by the state in the seventeenth century, caused skilled labour and commerce to move to other centres, diminishing its once thriving grain trade (Hudgins, 1997). Mercantilism also sought to safeguard the general organization of guilds, workers' wages and prices. In France, the guilds were nationalized. In England, the existing town and rural organization was unified through the Statute of Artificers (1563). So pervasive was the Statute that according to historian S.T. Bindoff:

> *[...] the restrictive principle had, like some giant squid, fastened its embracing tentacles round many branches of domestic trade and manufacture," and ″in the last decade of Elizabeth's reign scarcely an article in common use – coal, soap, starch, iron, leather, books, wine, fruit – was unaffected by patents of monopoly.* (Bindoff, 1950)

The Poor Law in 1601was enacted to deal with the rural labour dislocation caused by the conversion of much crop land to sheep grazing enclosures that was fuelling England's wool manufacture. The observation of individuals "unattached to the manor or any feudal superior" sounded an alarm in England in the seventeenth-century. and the social and economic causes of the new pauperism became the subject of much literature and several humanitarian and religious movements. In 1660, Thomas Lawson published an *Appeal to the Parliament concerning the Poor that there be no beggar in England*, testifying to the disquiet over the new class of poor.

> *The English Corn Laws, which existed in some form since the reign of Henry III (1225), underwent a change during this time. Originally intended to guard against the scarcity of bread, as the agricultural revolution progressed by enclosing common lands, consolidating small plots and severing the feudal bonds between land owner and tenant, the payment of rents took prominence.* [8]

[8] For an excellent dissertation on the Corn Laws, see Marks (1908).

> *Under the new [Tudor] regime, Money took the place of Men. It was no longer "The yeomanry must not be destroyed, the King must not lose his foot soldiers;" but, "Rents must not fail, the value of land must not decline." In England, in the seventeenth century, "Agricultural Depression" did not mean that bad harvests were ruining farmers by giving them less corn to sell, it meant that harvests had been too abundant, Nature too bountiful, and so corn was cheap and the farmer could not pay his rent". (Marks, 1908)*

Not surprisingly, then, while European powers battled each other for supremacy and sought a stable domestic food supply, commodity futures markets did not develop during this period and the notorious speculative fevers that erupted in the seventeenth and eighteenth century, such as "tulip mania" (1637) and the "South Sea bubble" (1720) involved schemes of a more exotic nature.

By the late eighteenth century, the Enlightenment had stirred an eruption of new political and economic ideas. Adam Smith wrote *The Wealth of Nations* (1776), Echoing Smith, Immanuel Kant in 1795 rejected the mercantilist dogma in the prophetic *Perpetual Peace*, asserting that only representative Republican governments which respected autonomy and universal hospitality could be trusted to keep citizenries out of war. David Ricardo, after amassing a fortune on the London Stock Exchange, articulated his renowned theory on comparative advantage in 1817. As an early gold bullionist, he theorized that lax monetary policy was the cause of Britain's inflation. A wave of bullionist thinking eventually led to the 1844 enactment of Peel's Law, requiring the Bank of England to control banknote issuance and maintain a statutory level of gold reserves.

In 1830, England abolished its centuries-old Settlement Laws and Poor Laws, abruptly unshackling its labour force. It repealed its Corn Laws in 1848, and other countries began enacting similar reforms.

As nations eased trade barriers, commodities flowed around the globe and the grain trade dramatically increased. It was during this century that family enterprises replaced state monopolies: the major family grain companies – Continental – (founded by Michel Fribourg Belgium - 1813), Bunge (Netherlands -1818, later Bunge y Born, Argentina - 1884), Louis Dreyfus (France, Germany - 1851), Cargill (the United States of America - 1865) and André (Switzerland – 1877), emerged as giants of the trade – most of which are in dominance today.

Japan

Following the proto futures grain exchange in Amsterdam, the next centre to develop forward and eventually futures trade in grain was the Dojima Exchange in Osaka, Japan during the Tokugawa Period (1603 -1867). Following the development of warehouse receipts, called rice bills, the market emerged as an autonomous commercial development between rice buyers and sellers. The *bakufu* (officials), however, saw the trading in these bills as fictitious and the cause of inflation, and therefore shut down trading in 1705. It also confiscated the wealth of the warehouseman in front of whose house trading was conducted and declared void his credits to feudal lords (Schaede, 1989).

In 1730, when bountiful harvests together with monetary intervention were depressing rice prices, the government abruptly changed course and issued a decree to sanction trading at the Dojima Rice Exchange. Similar to today's futures contracts, the contracts in rice were centrally cleared and derived from an underlying asset - standardized in size and quality. Margining and mark-to-market accounting also existed although somewhat differently from modern exchange practices. The trade was lively and robust. At the end of the afternoon trading session, the settlement price was achieved by lighting a fuse attached to a box and the price realized at the point of extinguishment became the "fuse cord price." If traders continued to trade, then the exchange's designated brigade of watermen threw buckets of water on the traders to halt trading. The last price realized during this period became known as "the bucket price" and was used as the mark- to-market price (Schaede, 1989). The fuse cord price, however, served as the opening price the next business day.

The Government of Japan tried unsuccessfully to intervene in the Dojima rice futures market several times over the next 100 years. By 1940, trading on the Dojima Rice Exchange was suspended.

Developments in the United States of America

> *It is against the law to run a gambling house anywhere within the United States of America, but today, under the cloak of business respectability, we are permitting the biggest gambling hell in the world to be operated on the Chicago Board of Trade.* (US Senator Arthur Capper, 1921)

Commodity markets in the American colonies existed haphazardly from early on. In 1666, a corner on the wampum market was recorded. In 1697, "The Exchange" was operating commodity trading in fuel and grain on Broad Street in Manhattan. Speculation increased during the Revolution and the War of 1812, sometimes disrupting the war efforts (Markham, 2001). Commodity centres arose in Baltimore and Philadelphia but did not result in formal establishment. The United States of America Supreme Court gave validity to commodity speculation when it ruled that a tobacco trader could legally profit from advance notice of the signing of the Treaty of Ghent in 1817, which caused a steep rise in tobacco prices. Stating that a purchaser need not disclose price sensitive information to the seller of a good, Chief Justice Marshall held that, "It would be difficult to circumscribe the contrary doctrine within proper limits, where the means of intelligence are accessible to both parties" (Markham, 2001). Legal certainty of commodity transactions was key to the American exchange experiment.

The most famous and still extant futures exchange to emerge in the nineteenth century was the Chicago Board of Trade (CBOT) in 1848. Organized originally by 82 members as a cash market, it also provided rules for ethical trading practices and reliable standards of weights and measures. Soon after the founding of the exchange, grain brokers began trading in "cash forward contracts," and eventually futures and instruments called "privileges" – the equivalent of options. The rationale behind this innovative marketplace was to mitigate the price swings of the harvest cycle - the trough caused by distressed harvest selling (grain often rotted on the ground) and the subsequent sharp peaks as end-of-season supplies ran short.

Chicago's geographic location at the southern edge of Lake Michigan and at the centre of extensive rail lines made it ideal as a trans-shipment hub and, combined with its commercial activity, was pivotal to the "Great European Grain Invasion" lasting from 1870 to 1913. Besides the easing of import tariffs in Europe, a revolution in American transport, transport networks and infrastructure facilitated mass shipments of grain eastward. By 1836 the first steamship cargo of Midwestern wheat sailed the Great Lakes to Buffalo, New York. By the 1840s, the Erie Canal linking Buffalo further east to Manhattan was shipping millions of tons of wheat at freight costs of USD 10 per tonne compared with USD 100 per tonne by road. The adoption of grain quality standards,[9] swift advances in mechanization, and burgeoning

9 Adopted in the state of Illinois, 1870.

wheat production across the upper plains propelled the United States of America into the premier global wheat exporter, overtaking Prussia and its Black Sea neighbours.

> *Many contemporary [nineteenth century] critics were suspicious of a form of business in which one man sold what he did not own to another who did not want it [...].* (Rothstein, 1966)

The CBOT, recognized from the onset for its legitimate commercial purpose, nonetheless drew Congressional attention soon after the start of futures trading. In 1882, a Senate Committee was charged with investigating "corners and squeezes" in oat and wheat futures and possible manipulation of rail shipments (New York Times, 1882[10]).

Corners, squeezes and bear raids were a frequent occurrence at the CBOT for decades. The most renowned wheat corner was perpetrated by Joseph Leiter in 1889 which caused wheat prices to appreciate by about 50 percent. In response, another giant speculator P.D Armour chartered tugboats to break the ice in Lake Michigan allowing wheat to flow towards Chicago and accordingly: "The Northwest scraped its granaries, Russia ate rye ... and Argentina swept the floor." An "avalanche of wheat"[11] arriving in Chicago broke the price causing Leiter to default on his obligations.

Responding to the new world of commodity price volatility, other forward/futures exchanges emerged at this time – Liverpool, (roughly the early 1800s), Frankfurt (1867), Alexandria, Egypt (1871),New York (1872), Vienna (1872) Bombay (1875), London (1877), Hamburg (1880), Izmir, Turkey(1891), Winnipeg, Canada (1904) and Rosario, Argentina (1909).

As Chicago grew in importance in establishing the price of grain, the Farm Alliance and other farm groups demanded federal regulation of the CBOT. The Democratic Party introduced several measures favouring the suppression of "the pernicious practice of gambling in agricultural products by organized exchanges [...]"(Himmelberg, 1994) – none of which passed. During WWI the Government of the United States of America became involved in grain distribution its Allies, at which time wheat exports tripled and the price rose to USD 3.25 per bushel. According to the historian Murray Rothbard,

> *[...] under pressure by the agriculturists, the government programme fixed by statute, not maximum prices for wheat but minima; the Food Control Act of 1917 fixed a minimum price of two dollars a bushel for the next year's wheat crop. Not content with this special subsidy, the President [Wilson] proceeded to raise the minimum to two dollars and twenty-six cents a bushel in mid-1918, a figure that was then the precise market price for wheat. This increased minimum effectively fixed the price of wheat for the duration of the war.* (Rothbard, 1972)

After the War ended, prices slumped and the farm bloc demanded and obtained the first federal futures market regulation. The Grain Futures Act (GFA) of 1921, however, was soon declared unconstitutional owing to its taxing power provision. Another Act followed in 1922 which required exchange disclosure of traders, record keeping and anti-manipulation measures.

The GFA did not end market manipulation, however. After a substantial rise in wheat prices in 1924, a Senate investigation found that some speculators had concealed their trading through the use of several accounts. The investigation determined that one of the worst abusers was CBOT member Arthur Cutten. Cutten made reportedly USD 11 million in pushing the wheat price from USD 1.05 to over USD 2.00. When cargoes of Argentinean

10 New York Times "The Gambling in Grain", April 18, 1882.

11 Reportedly six million bushels.

wheat arrived in Chicago collapsing the corner, however, Cutten was forced to buy more wheat. A Congressman later would remark that, "Cutten owned more ...grain than anyone since Joseph of Egypt." (Markham, 2001)

During the same time, the GFA administrators "recommended some limitations on [...] longs and shorts [...]" and thought it "advisable to place some limitation upon the extent to which prices of grain futures could fluctuate within a single day"(Markham, 2001). Then United States President Herbert Hoover, who had voiced his support for the hedging function furnished by the CBOT, remarking "that it cheapened the cost between farmer and consumer by reducing the risk", subsequently pronounced that he knew of no more "glaring exhibit than these millions taken by sheer manipulation of the machinery provided by the Board of Trade"(Markham, 2001).

The farming community, too, was suspicious of the CBOT, particularly after it denied Farmer's National - a cooperative – exchange membership. Alexander Legge, a former Farm Board Chairman complained in 1932 that the members of the CBOT "have set up a little government of their own, in which trials are held like a secret lodge, no lawyer being allowed to represent the client, and there being no appeal from their decisions to any court of record" (Markham, 2001).

In 1936, responding to complaints about trading on the exchanges, Congress enacted the Commodity Exchange Act "to facilitate honest and fair practices and to restrain fraud, excessive speculation and manipulation in commodity exchanges" (Stassen, 1982).

Global protectionism and monetary instability after WWI

Following WWI, the liberal creed of laissez-faire imploded. As countries debased their currencies to fund the war effort, the system of fixed currencies based on the gold standard fell apart like a spoked wheel without a hub. No other war had changed the map of Europe so dramatically - four empires disappeared: the German, Austro-Hungarian, Ottoman and the Russian. Because the United States of America came late to the conflict and managed to remain on the gold standard, it emerged the strongest in the aftermath. Other countries, however, grappled with re-establishing a working monetary system.

Against this backdrop of hyperinflation that ravaged the economies of Russia, Austria, Hungary, Poland, Bulgaria and Germany, the restoration of the gold standard and the fixed-rate currency system was a tenet common to all political and social doctrines of the new Europe. Russia, whose leader Vladimir Lenin had espoused a non-money economy, was first to stabilize its currency (ruble) to gold in 1923. In Italy, Prime Minister Benito Mussolini waged a nationalistic battle - *Quota Novanta* - vowing to restore the weakened Italian Lira to the pre-war level of 90 against the British Pound (itself fixed to gold in 1924). In an opposite move, France devalued its currency to one fifth its former level in order to gain a competitive export advantage. Britain symbolically fixed its currency at the pre-war level at USD 4.82 and quickly saw a 12 percent surge in unemployment. Previously considered a purely economic institution, an unstable world discovered that a single money standard was also a social mechanism, underpinning the welfare of swaths of agriculturalists and workers. (Polanyi, 1957)

Once currencies were re-fixed to gold,[12] they came under speculative attacks and government intervention. Also common were bank panics: a bank failure in Austria in 1931 ignited a wave of bank runs (in which depositors demanded specie) across the financial world. That same year, Britain left gold and devalued its currency, creating a de facto Sterling

[12] Several South American and Asian countries refixed to a silver standard tied to a gold ratio.

currency zone for nearly half the world. Eight years earlier, the British economist John Maynard Keynes, had damned the gold standard for its stringency, calling it a *barbarous relic*.

In a review of the interwar period, the current United States of America Federal Reserve Chairman describes the impossibility of reconciling the two opposing trends that eventually tore the gold standard apart: "central banks could do little in the face of combined banking and exchange-rate crises, as the former seemed to demand easy money policies while the latter required monetary tightening" (Bernanke, 2000). In the late 1920s, when the United States of America Federal Reserve countered inflation with monetary contraction, it helped trigger a worldwide depression.[13]

A recent analysis, "Commodity Market Disintegration in the Interwar Period" (Hynes et al., 2009) documents the increase in trade costs relative to commodity values following 1929. Examining commodity prices at origin vs. landed prices, it verifies increases in trade costs of 160 percent between 1913 and 1933, ascribing these increases to protectionist tariffs, scarcity of trade finance and the breakdown of the gold standard. Citing from the *Winnipeg Free Press:*

> *By 1931, complaints still abounded about "the spasmodic nature of export buying" and worries over the fact "that speculative trading [was] at an absolute minimum and exporters show[ed] interest only at wide intervals" remained (1931). There was also the impression that "rarely, if ever" had the exchange witnessed "such a dull and featureless grain market" (1931). Soon, a new concern had also arisen: "few, if any traders, dreamed that before the end of another week Great Britain would have abandoned the gold standard...and that owing to these things export of Canadian wheat to the United Kingdom would be practically at a standstill.*

So monumental an event was Britain's abandonment of gold standard that, "The Tokyo Stock Exchange had announced that it would not open. Tokyo was followed by Bombay, Calcutta, Johannesburg, London, Berlin, Amsterdam, Copenhagen, Vienna, Oslo, Stockholm, Brussels and Athens. The Paris Bourse opened, but limited all trades to 5 percent of all holdings and no dealing in foreign exchange. Montreal's Exchange opened similarly restricted. The New York Stock Exchange remained open, but as in dark November 1929, short selling was forbidden. In the artificial market thus created, stocks gyrated unsteadily, closed higher; bonds closed at lows for the year."[14]

As global protectionism replaced the doctrine of *laissez-faire*, world trade collapsed by 66 percent. The United States of America left the gold standard in 1933 and the other countries operating on a "dirty float" arrangement abandoned gold by 1937. Conferences in Brussels, London, Lausanne, Geneva and Locarno failed to reinstate a pre-war stable monetary system to allow for the resumption of trade. Some countries reverted to barter: Germany conducted trade through bi-lateral barter arrangements with the nearby Balkan states and across the Atlantic with Brazil and Argentina, bypassing the banking system altogether. The collapse of the monetary system would also coincide with the demise of the liberal state as autarchy and totalitarianism erupted out of war's wreckage in Europe, South America and Asia.

Commodity dependent countries reeled during this period as commodity prices spiralled downward. In an article written for *Foreign Policy Associates*, Stephen Naft observed: "The decline in the prices of coffee, copper, tin, nitrates [...] and rubber [...] all but shattered the economic structure of South America. Budget deficits, [an] inability to pay the salaries of government employees, numerous bankruptcies and mass unemployment called forth

13 The New York Fed's discount rate, at 3.5 percent in January 1928, reached 6 percent by August 1929, its highest value since 1921.
14 Excerpted from Time Magazine, August, 1931.

general discontent [...] and bewilderment. One of the consequences was a large crop of military revolts and similar uprisings" (Naft, 1937). Cuba, highly dependent upon its sugar exports, saw its economy collapse as sugar prices fell from a high of USD 0.11 per pound to USD 0.02, sparking a revolt in 1933. The increasingly chaotic monetary system and its effects on credit and commodity prices prompted Herbert Hoover to pronounce in 1931:

> *The restriction on credit has grown greatly in the past few weeks. There are a multitude of complaints that farmers cannot secure loans for their livestock feeding or to carry their commodities until the markets improve. There are a multitude of complaints of business men that they cannot secure the usual credit to carry their operations on a normal basis and must discharge labour. There are complaints of manufacturers who use agricultural and other raw materials that they cannot secure credits beyond day to day needs with which to lay in their customary seasonal supplies. The effect of this is to thrust back on the back of the farmer the load of carrying the nation's stocks. The whole cumulative effect is today to decrease prices of commodities and securities and to spread the relations of the debtor and the creditor.* (Hoover, 1957)

After the Government of the United States of America attempt to create a floor under grain prices, a news writer provided this narrative: "Three weeks ago Chicago's Board of Trade, instigated by Washington, set a temporary level below which grain future prices would not be allowed to sink. Last week that artificial floor was removed. Prices which had been bobbing along on the rule like balloons without lifting power promptly dropped the maximum amounts permitted in one day's trading. Great was the hullabaloo."[15]

WWII and its aftermath

The commodities trade and currency system changed substantially following the Second World War. Protectionism persisted after the War. Servicing the war debt which burdened the major European nations, put their balance of payments under great strain. While Europe and East Asia lay in ruins, the United States of America emerged in a dominant position: besides holding 80 percent of the world's gold, it boasted a booming capital market and produced half the world's coal, two-thirds the oil, and more than half the electricity. With only 6 percent of the world's population, it generated 40 percent of global industrial output.

Needing markets, the United States of America used the 1944 conference at Bretton Woods to put forward a new monetary arrangement. Rejecting the Keynesian plan of a central clearing house using a universal currency called the *bancor*, it advanced a system of American based monetary institutions and a currency formulation that would stamp the United States Dollar with reserve currency status.

Under the Bretton Woods system, currency parities were "pegged" rather than fixed to the United States Dollar giving the system flexibility. The United States Dollar was then fixed to gold at USD 35 per ounce creating a quasi-gold standard system. The arrangement cleverly solved the problem of bank runs, as the public could not redeem foreign currency in gold equivalents and, the United States of America had outlawed gold coin ownership since 1933. The International Monetary Fund (IMF) would administer the stabilization fund by making short-term loans (in dollars) to any country suffering a balance of payments problem that might threaten currency alignments.

The disruption to the world economy by WWII put a halt to many commodity futures trading centres. Some countries simply banned futures trading altogether as too speculative.

15 Excerpted from Time Magazine, 1933.

India for example, had thriving futures markets in Bombay and Calcutta as well as several other cities trading in cotton, jute, spices, wheat and oilseeds commencing in 1875. As a sophisticated trade, traders in the Indian cotton market often undertook arbitrage with other major international cotton markets, such as Liverpool, New York and Alexandria. A complete regulatory framework for futures trade governed operations, including rules and conditions for futures transactions, brokers' licensing and clearinghouse functions. However, futures trading was restricted during World War II, not to be restored until 2004:

> *Options on oilseed and cotton, food grains, spices and sugar were first banned. The inflation of the later war years was a direct outgrowth of conscious government policies designed to meet exigencies of the war effort. The imperial administration, concerned with obtaining railway wagons for military transport, placed serious restrictions on the commercial use of the railways, causing shortages in most essential commodities imported into the city. The spiralling prices fuelled speculative activity in the futures markets, and futures trading was halted owing to rampant hoarding.* (Hathaway, 2007)

The Cotton Exchange in Alexandria Egypt (1885), which also dealt in cereals, was effectively shuttered by agrarian reform measures passed in 1950. Similarly, the Rosario (1909) and Buenos Aires (1907) exchanges in Argentina, which had experienced an annual trade volume of 20 million tonnes in the 1920s, saw commodity trading dwindle to negligible levels as the "Government established a monopolistic market, acting as the only buyer of crops, thus eliminating free market transactions" (Basurto & Caram, 2009).

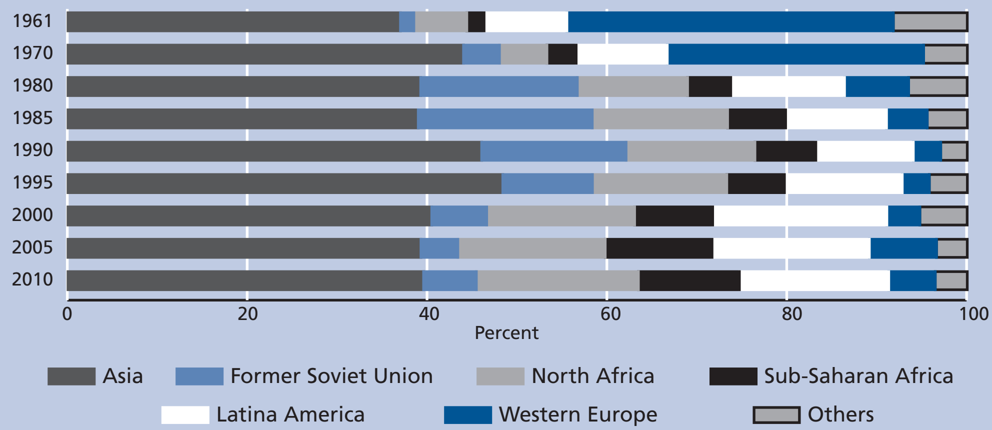
Seeking to integrate its recovering national economies, in 1957 Europe established the European Economic Community in under the Treaty of Rome, initially involving Belgium, France, Germany, Italy, Luxembourg and the Netherlands. Simultaneously, it formulated the Common Agricultural Policy that allowed for the free flow of agricultural goods within the EEC and placed tariffs on third country imports. The system provided producers with subsidies in the form of direct price supports for commodities produced. Designed to protect producers from the volatilities of global markets and eventually create self sufficiency (Western Europe was the single largest wheat importer until the early -1970s as shown in Figure 13.1, CAP impeded a revival of futures trading in cereals and oilseeds for the next several decades.

Although futures trading in the United States of America restarted after WWII, a price support system administered under the Commodity Credit Corporation radically diminished the pricing function of futures. With few exceptions, prices and futures trade languished during the 1950s and 1960s. The early 1970s proved another matter. In 1971, the United States of America President Richard Nixon announced that grain sales to the USSR and the People's Republic of China would no longer be subject to the Export Control Act that required United States flag carriers to transport half the tonnage shipped to these countries. The result was a massive vessel chartering and grain purchase programme by the USSR (aided by substantial United States export credits), which went unannounced for months. As the multi-million ton sales were revealed, grain prices exploded. They continued to move still higher as an Australian drought slashed global production and India tendered for sizable quantities of wheat.[16]

The demand shock in grains was exacerbated by the United States of America decision to suspend US Dollar/gold convertibility. While the war in Southeast Asia was increasingly

[16] In reaction, the Government of the United States of America stepped up its international crop surveillance and instituted export reporting procedure to ensure that such an episode would not be repeated. These programmes have been maintained and are of great value to the grain trade.

Figure 13.1: World wheat trade shares



Source: FAO

straining the United States of America financial system, the Government of France demanded gold in exchange for United States Dollar liabilities (the London gold market was valuing the United States Dollar at about USD 45 per ounce). In August 1971, vowing that “the American dollar must never again be a hostage in the hands of international speculators,” President Nixon announced that he had instructed the Treasury to suspend convertibility of the United States Dollar into gold. The administration had failed to appreciate the loss of faith in its currency owing to the deterioration of its gold/foreign liabilities ratio: In 1953, the United States of America gold reserves exceeded foreign liabilities by threefold; by 1970, foreign liabilities were five times greater than gold reserves.

The United States Dollar sank 30 percent against other major currencies while gold - unmoored from its USD 35 an ounce peg - rallied to USD 200 by 1974. The price of maize, which had dipped below USD 1 per bushel, traded close to USD 4 per bushel, soybeans soared to USD 12 per bushel and wheat topped the USD 6 mark. Compounded by the petroleum crisis in 1973, the inflation experienced in the United States of America finally culminated in wage and price controls.

Birth of financial futures

The end of Bretton Woods arrangements gave rise to the mammoth futures market of financial instruments. To enable trade between the United States Dollar and foreign currencies, Chicago Mercantile Exchange swiftly launched seven currency futures contracts in 1972: British Pound, Canadian Dollar, Deutsche Mark, French Franc, Japanese Yen, Mexican Peso and Swiss Franc. Seeing the opportunities of a volatile interest rate environment, the CBOT launched United States debt instruments, starting with the mortgage backed Ginnae Mae followed by the 30 year Treasury bond contract (1975).

The innovation of exchange traded financial futures spurred the creation of the Commodity Futures Trading Commission in 1974. The United States of America Congress vested the CFTC with broad oversight and anti-fraud powers, including the authority to approve position limits and the specifications of all futures contracts listed on United States exchanges to ensure that they are resistant to manipulation.

Financial futures trading revolutionized credit markets, including consumer financing. Mortgages that had been traditionally based on fixed rate 30 year loans became flexible, retail credit that had only been extended on a store to customer level became intermediated by credit card companies. These new forms of financing became increasingly mainstream, particularly after interest rates declined from double digit levels.

On the institutional level, a new industry emerged outside the oversight of the CFTC. In 1982, the International Swaps Dealers Association established itself, "to encourage the prudent and efficient development of the privately negotiated derivatives business." Initially, most of the transactions were standard interest rate swaps – often hedged at the CBOT. But unlike the futures trade that was centrally cleared in which buys and sells were offset, the swaps book consisted of strings of bi-lateral transactions that burgeoned into a USD150 trillion open interest by 2004, causing financier Warren Buffet to call these instruments – Weapons of Mass Destruction.

Elsewhere during the 1980s, financial futures markets multiplied. Following the easing of capital controls, the London International Financial Futures Exchange (LIFFE) launched in 1982, followed by Marchés A Terme d'Instruments Financiers (MATIF, Paris 1986) and Deutsche Börse in 1990. As intervention cereal stocks were declining and CAP reformed its producer subsidies from commodity specific price supports to direct compensation schemes, MATIF launched a rapeseed and milling wheat contract in 1988. LIFFE absorbed the London Commodity Exchange in 1996 that had been a trading centre for coffee, cocoa and sugar for several decades.

Global effects

The market liberalization that swept across the globe starting in the 1990s generated a surge in commodity exchange and derivative market development. The new exchanges differed markedly from previous models – shifting their focus from commercial concerns to producer needs. Income growth, rising demand for agricultural products and a reduced scope of price support systems[17] created a need for risk management centres to deal the resultant regional price volatility.

In addition to economic and political forces, the technological revolution proved highly instrumental in exchange development. By incorporating instant audit trails and safeguards against fraud, market manipulation and execution errors, the electronic trading system that began in Europe in the mid-1990s was pivotal in establishing market integrity, as it required less regulatory supervision than the traditional open outcry system. The superior oversight and surveillance functions allowed electronic exchanges to gain overwhelming government endorsement, even in countries such as China (Mainland), India and Thailand that previously halted or banned commodity futures trading. In addition, the trend toward restructuring the governance of the exchanges from mutually held, often exclusive, membership associations to transparent shareholder organizations instilled participant confidence in exchange integrity.

Information technology provided an equally important producer benefit welcomed by governments: price transmission. Historically, most commodity exchanges developed as physical transaction hubs where producers delivered and sold their crops to buyers with

[17] Some countries, such as Argentina, Brazil, New Zealand and South Africa, opted for the complete elimination of price supports.

storage facilities, having to accept the spot offer price. Market fragmentation – i.e. poor price correlation among the regional exchanges – also characterized the exchange network. As the new electronic exchanges broadcast multiple prices from various markets – spot and forward, they gave producers a range of seasonal and geographic options for storing or marketing their crops. In short, governments realized that exchanges helped confer pricing power to the producer. Combined with their enhancement of institutional development – e.g. grading and warehouse receipt systems, supply chain integration and farm credit facilitation, exchanges became seen as desirable national policy initiatives. As an example of the newfound producer focus, the South African Futures Exchange designated over 100 delivery locations in its corn and wheat contracts to encourage farmer participation following the elimination of price supports. Several emerging countries saw the establishment of a futures exchange a mark of modernity – in Turkey, Prime Minister Erdoğan inaugurated the Turkish Derivatives Exchange in 2005 in Izmir.

Emerging market exchange development, however, was not without several hitches. As a front runner in this field, China (Mainland) saw too rapid a growth starting in the mid-1990s:

> *[...] the frenzied growth of China's futures markets was accompanied by rampant abuse, triggering two waves of reform, the "First Rectification" and the "Second Rectification." The First Rectification was launched with the publication of a directive informatively titled The Notice of Firmly Curbing the Blind Development of the Futures Market. Over the subsequent five years, authorities slashed the number of exchanges from over 40 to 15, delisted 20 futures contracts (leaving 35), began issuing licenses to futures commission merchants for the first time while lopping their number by over 70 percent, restricted trading on foreign futures exchanges, introduced new rules and regulations, and shifted the control of the exchanges from local governments to regulatory authorities.* (M. Gorham, 2005)

The reforms eventually left three exchanges – Zhengzhou, Shanghai and Dalian – each with a separate product base – which today stand as some of the largest exchanges by contract volume.

In Thailand, manipulation of the rice contract caused the exchange to halt rice trading. The Government of India suspended trading in wheat, dal, tur, potatoes and rice in 2007 when it witnessed an inflationary trend in the prices of these commodities. The wheat and cotton contracts failed to gain traction at TURKDEX, which today is strictly a financial derivatives exchange.

The United States of America derivatives revolution

By the mid-1990s the Over the Counter (OTC) market in interest rate swaps was in full swing, topping USD 10 trillion in notional amounts of outstanding contracts. The opaque market made headlines in 1995 when the firms Proctor and Gamble and Gibson Greeting Cards sued Banker's Trust for "misleading" them about the riskiness of derivatives transactions sold to them. One of the swaps, called a ratio swap, tied Gibson's interest rate payments to the *square* of Libor divided by 6 percent (libor × libor/6 percent), causing its losses to explode as the London rate topped 6 percent. Nonetheless, the swaps business continued unabated, but took another turn when the Federal Reserve orchestrated a bail out of Long Term Capital Management by its creditor banks in 1998. The business had become cannibalistic – it would need wider avenues of growth.

Free market fervour and the movement for deregulation accelerated in the United States of America in 2000. The Commodity Futures Modernization Act allowed for the exemption of energy products from position limits (later to be called the "Enron loophole" when the energy firm collapsed) and the exemption of over-the-counter swaps and derivatives from CFTC oversight. More significantly, Congress overwhelmingly passed the Gramm, Leach, Bliley Act, repealing the Glass-Steagall Act of 1933 that had separated insurance functions and commercial and investment banking. Together, these acts provided the engine for staggering increases in futures trading volumes by firms that had no commercial interest in the contracts beyond profit making. According to Robert Reich[18]:

> *By 1999, Wall Street was salivating over such a [Glass Steagall] repeal because it wanted to create financial supermarkets that could use commercial deposits to place bets in the financial casino. That would yield the Street trillions.*

The CBOT also embraced the deregulatory spirit. Since the early 1990s it had been steadily increasing the speculative position limits in its agricultural markets with the approval of the CFTC. These limits, which had existed for decades at 600 contracts per commodity would finally grow to 22 000, 10 000 and 6 500 for maize, soybeans and wheat respectively by 2005 and were set to double when the 2006-08 high food price event hit.

When two renowned academics from Yale University and the Wharton School published "Facts and Fantasies about Commodity Futures," (Gorton & Rouwenhorst, 2004) commodity derivatives trading kicked into high gear. In a remarkable sleight-of-hand, the authors redefined commodity futures a distinct "asset class," upending their traditional role as hedging or risk transfer instruments. Examining commodity futures prices between 1954 and 2004, they proclaimed that they had less volatility and better returns than bond and equity markets and, because they were inversely correlated to securities, they were ideal investments for those seeking "portfolio diversification." Although the analysis did not include any costs associated with rolling positions forward – something necessary in actual position maintenance, the world of investment banks embraced the analysis with unfaltering faith. "Facts and Fantasies" became the doctrine enabling the banking and brokerage industry to persuade a whole new customer base into commodities "investment."

Tradable commodity indices - which had existed since the launch of the Commodity Research Bureau index in 1985 (NYBOT), followed by launch of Goldman Sachs Commodity Index in 1991 (CME) and eventually several others - now became a lucrative retail offering. The institutions selling these products would typically charge a customer fee of 2 percent of assets and 20 percent (or more) of profits. For the sales firms, nothing in the equity or fixed income world could compare with the profitability of the commodity index fee structure.

In fact, the commodity index retail fund might be viewed as one of the most ingenious innovations ever sold. As a reverse fixed-for-floating swap transaction,[19] it obliges the customer to deposit 100 percent collateral to purchase a basket of commodity futures. The sales firm then allocates the deposits as follows: 2 percent is collected up front as an annual asset fee; 8 percent (approximately) goes to the clearing house to cover the initial margins for the commodities involved; the remaining 90 percent is placed in T-bills. Customer funds cover 100 percent of losses incurred by declining commodity prices while profits from increased prices are split with the sales firm. Significantly, the customer funded 100 percent collateralized portfolio makes the sales firm immune to any counterparty or default risk. For

[18] Robert Reich, Wall Street Pit: Why the U.S. Economy Is So Out of Whack, 4 April 2010 <http://wallstreetpit.com/22245-greenspan-summers-and-why-the-economy-is-so-out-of-whack>

[19] Swaps usually involve an exchange of payment streams in which one party (the buyer) agrees to a fixed rate or price and the other party (the seller) a floating one. In commodity index funds transactions, the customer acts as the swaps seller to the sales firm, as the customer bears the market risk while the sales firm bears none.

the sales firm, the commodity index fund is a zero risk/high return product with no exertion - other than placing orders.

Not surprisingly, several firms petitioned for and received “hedge exemption” status, meaning that they could amass positions in excess of the already colossal speculative limits. According to Barclays Capital, about USD 320 billion dollars is invested in various commodity index funds today with most linked to the GSCI and the Dow Jones UBS commodity index fund (not inclusive of hedge funds).

In addition to index products, OTC swaps also became a significant agricultural market offering. The market is opaque – existing figures on the market depth, volume or purpose, are not public; so whether swaps are customized products intended to reduce price risk exposure or whether they are another form of speculation cannot be ascertained for now.[20] However, according to recent CFTC Commitment of Traders Report, Swap dealers have negligible short positions and hold substantial portions of the long open interest in agricultural commodities, i.e. 20 percent, 25 percent and 37 percent in CBOT corn, soybean and wheat contracts respectively.[21]

Speculation has received commendation from high ranking officials, economists and popular pundits. Former United States Federal Reserve Chairman Alan Greenspan consistently praised derivatives trading as creating market efficiency and told a Senate hearing in 2006 on energy that market speculators also have been able "to hasten the adjustment" to higher prices and “eased the shock to the economy.” Nobel prize winner and New York Times editorialist Paul Krugman utterly dismissed the idea that index investing amounted to “virtual hoarding” an idea proposed by hedge fund manager Michael Masters before a United States Senate sub-committee in 2006 (Masters, 2008).

The *Economist* and the *Financial Times* also have frequently minimized the possible price impacts of speculation, ascribing price movements instead almost entirely to supply and demand fundamentals. Two articles in the Economist (June26, November 19, 2010) made assertions that there was “almost no evidence” to connect commodity speculators with commodity price spikes. In July 2010, an FT article lionized the edge fund owner of Amarajo, which took delivery of 240 000 tonnes of cocoa in the LIFFE Euronext market, calling his trades “devilishly brilliant.”(Financial Times, 2010)[22]. It dismissed the idea that “snapping up” virtually all of the deliverable supply amounted to a corner, even though the record price of cocoa induced the shipment of African origin cocoa from New York warehouses back to the northern European delivery points of Amsterdam and Antwerp. [23] When cocoa prices dropped over 30 percent within a month, the FT did not follow-up on the price spike and collapse, leaving important questions unexamined and unanswered.

As for-profit entities, the exchanges themselves have become forceful marketers of their own products and the merits of commodity futures. Having merged the CBOT, COMEX and NYMEX into the CME Group, the super-exchange has a ubiquitous presence in trade journals, newspapers and broadcast media. Euronext LIFFE[24] also vaunts its rising presence in commodity futures trade, openly challenging the CME for dominance. Saying

20 The CFTC since 2008 has made a “special call” to swaps dealers asking them to divulge their swaps book, but does not publish the findings.

21 As of November 16, 2010.

22 Financial Times. 2010a. "Man in the News: Anthony Ward", July 23.

23 In United States futures markets, such a movement of commodities would be considered a “distortion of trade” and not allowed to continue. See also Financial “Chocfinger is no Bond Supervillain” July 20 (2010).

24 The exchange includes the LIFFE and Matif product complex of coffee, sugar, cocoa, wheat, rapeseed, corn, feed wheat and other agricultural products.

that commodity investing "has never been easier," in the 2010 Summer issue of Swiss *Derivatives Review*, a Euronext LIFFE director reproaches CBOT grain contracts for their lack of convergence between cash and futures, (Dudden, 2010) encouraging traders to switch to its products.

Academic analyses have also thrown support to the entrance of new types of speculators. In 2008, Sanders, Irwin and Merrin (Sanders et al., 2008) argued that the level of passive index fund investing stabilized after 2005 in agricultural markets and was beneficial in absorbing the short hedging needs of the market. In another analysis written for the OECD, the authors applied Granger causality to the grain markets to determine if the levels of long positions held by index traders were predictive of price; they concluded "no" (Sanders et al., 2008).

As an isolated contrarian study, UNCTAD's 2009 Trade and Development Report countered the prevailing creed of free market orthodoxy, contending that the massive inflow of fund money had caused commodity futures markets to fail the "efficient market" hypothesis. Calling the steep rise of institutional inflows into commodity futures the "Financialization of Commodity Markets," it argued that swap dealers and index funds ignored supply and demand fundamentals when making decisions to buy or sell commodity futures, (UNCTAD, 2009).[25] The Report concluded that dealers/funds distorted proper price discovery. The CBOT itself raised the same concerns about the lack of convergence between futures and cash and the permanent contango[26] in the wheat market, coinciding with the increase in fund activity.

A new framework

Structural changes in global commodity markets have greatly contributed to rising prices and increased price variability. These fundamental trends toward higher prices have been a key lure for increased speculative activity on the major futures exchanges. Most factors contributing to higher prices and higher speculative volumes have been widely cited by economic journals and can be summarized as follows:

- Markets liberalization and decline of price supports.
- Deregulation of the financial service sector in the United States of America that allowed proprietary trading by banks.
- Declining margins in securities trading.
- Diversion of some foodstuffs into fuel products.
- Rising demand for food in emerging markets.
- Under-investment in agriculture owing to prolonged low food prices.
- Low price transmission to producers in agriculture.
- Sudden governmental interventions in the export market such as export bans, tariffs and quotas
- Ease of access to electronic market place
- Restructuring of primary exchanges from member organizations to for-profit corporations
- Expansive monetary policy

Speculation is a necessary part of futures markets. Without it, hedging pressure would create stochastic markets and disable their risk transfer capacity. A 1960s study by Holbrook Working established a ratio of speculators to hedgers, stating that a *T*-Ratio of at least 1.15 was needed to absorb hedge orders. Today, however, the question might be reversed – is there

25 Timed rather to prospectus dates or subscription levels.

26 A futures market structure in which each successive contract is priced higher than the one preceding it.

a ratio sufficient for hedgers to absorb the speculative activity? The annual volume of trade in the CBOT wheat contract for 2009 was about 90 billion bushels – the equivalent of trading the Soft Red Wheat crop every business day.[27] Even if commercials were heavy participants in this trade volume – most of their buying and selling would have to be deemed speculative as well.

Poorer countries deserve answers to the question: in what proportions are speculative vs. fundamental forces driving commodity futures price formation? As food is the largest single expenditure for over a billion people in this world, price hikes in basic staples simply means reduced consumption of food. According to the International Food Policy Research Institute:

> *The excess price surges caused by speculation and possible hoarding could have severe effects on confidence in global grain markets, thereby hampering the market's performance in responding to fundamental changes in supply, demand and costs of production. More important, they could result in unreasonable or unwanted price fluctuations that can harm the poor and result in long-term, irreversible nutritional damage, especially among children.* (Robles et al., 2009)

High and volatile benchmark futures prices unleash a chain of events in food distribution networks tending to fuel futures prices even higher. In 2008, this chain of events resulted in record high prices. As estimates for stock-to-use ratios in wheat declined to the lowest levels in 30 years, prices shot up. Hoarding, government controls and protests in about 30 countries erupted. Finally, India, Pakistan, the Russian Federation, Ukraine and Argentina all took measures to constrain exports. Consequently, demand was funnelled into the United States of America market and CBOT wheat futures soared to USD 12 per bushel, before breaking back to under USD 5 per bushel the following year.

Furthermore, fluctuating markets make planting decisions far riskier than ever; price signals observed during planting may completely reverse by harvest, causing great hardship. As Jayati Ghosh observes, "the world trade market in food has started behaving like any other financial market: it's full of asymmetry". So farmers think, "Well, wow, the price of sugarcane is really high" and they go out there and cultivate lots of sugarcane. By the time their crop is harvested, the price has collapsed. So you get all kinds of misleading price signals. Farmers don't gain".[28]

Poorer countries also suffer from monetary policy effects when food prices rise. Most developing countries' price indices are heavily weighted in food. In both India and China, the central banks are responding to domestic food inflation by raising interest rates. These rate hikes may produce more harm than good by stifling business growth and farm productivity instead of stabilizing food prices.

Unfortunately, the will to examine the issue of speculation barely exists. In the richer countries - hosts to the quadrillion dollars a year futures exchanges - obesity, not food deprivation, is the greater concern. Hunger and starvation are abstractions seen through the intermediation of a flat screen TV. Revealing how the general population is unperturbed and largely unaware of the thirty-fold increase in speculative agricultural "investment" in 6 years - a September 2010 Financial Times/Harris poll found that only about 10 percent of respondents in United States of America and the United Kingdom believed that speculators were responsible for the rising food prices. As higher futures prices only marginally impact the price of foodstuffs consumed in both countries owing to a diet of highly processed

27 The annual soft red winter wheat crop in the United States of America is about 400 million bushels – 10.8 million tonnes.

28 Interview with therealnews.com, 2010.

packaged foods with high marketing costs, their perception is probably not inaccurate.[29] Many asset managers and traders also claim that the world of currency chaos and expansive monetary policy has forced their trading strategies; pleading the hardship of reversal of fortunes – they contend that ownership of United States Dollar denominated commodities is a Darwinian form of "survival strategy."

Also, in modern celebrity culture, "big traders" have become "aspirational" figures. Gone are the images of frenetic locals clad in polyester jackets; today's sleek suited traders are the picture of wealth - worthy of imitation. Financial firms involved in derivatives trading employ over 1 600 lobbyists in the United States of America to help burnish their image as providing a grand social good, even though derivatives trading does not directly contribute to a nation's Gross Domestic Product (GDP). Many officials in the "watchdog" organizations are pulled directly from the investment bank community, reinforcing the "interlocking directorate" phenomenon between big business and government, first observed in 1956, by sociologist C. Wright Mills.[30]

Methodology

Most attempts to date to quantify the effects of speculation in agricultural markets have failed. The available data – provided via exchanges to the CFTC – cannot adequately address the issue. Also, the CFTC has only recently changed its reporting system; today it provides a detailed disaggregated report that more accurately reflects the new entrants into the market. Unfortunately, the higher level of disaggregation makes year-to-year comparisons impossible. For example, it previously placed "swaps dealers" in the same category as commercials, but now assigns them a separate category. It has also created another category of "managed money" – presumably hedge funds that use long, short and spread strategies without bias. Although significant and groundbreaking, the COT report only provides a weekly snapshot of categories of longs and shorts and not trading activities. Ownership (long and short) is an important informational component - however, open interest does not move markets. Open interest does not reveal the buying or selling patterns by the various trader categories on a particular day.

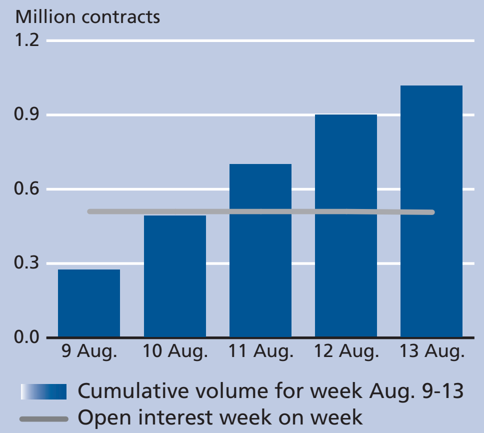
Indeed, by the time the CFTC publishes its weekly report, futures markets may have moved up the daily price limits for three days and collapsed under expanded limits for the subsequent two days. One week's volume often surpasses the crop size by multiples, underscoring the significance of transactions and order flow versus weekly changes in open interest (Figure 13.2).

Now that markets are electronic, the daily "pit" commentaries previously provided by commission house merchants are gone - the information on the quantities bought and sold by various firms, including the major grain firms and hedge funds, is no longer available. But the exchanges could produce these reports with great precision. They possess a perfect audit trail on the buys and sales of every firm - including quantities, prices and time of sales. In addition, they have a window into the entire order book. If a market locks "limit up," they can see what firms have entered orders to buy "at the market" and the size of these orders.

29 Even with a wheat price of USD 12 per bushel, its price component in a one pound box of breakfast cereal (costing around USD 4) on the United States of America supermarket shelf would be about USD 0.20. This price structure of value added foods contrasts markedly with countries whose populations buy price-sensitive staples such as rice, wheat and legumes directly from local markets.

30 See Mills (1956).

Figure 13.2: Open interest in the CME soft red wheat contract (August 2010)



Despite over a million contracts traded, open interest change was negligible, indicating short-term nature of most transactions

With the expansion of limits at the CBOT, a single speculator can, for example enter an order for 22 000 contracts of corn[31] - 2.78 million tonnes - the equivalent of fifty-five Panamax sized vessels.[32] The illumination of actual trade and order book data may not settle every question about the primary drivers of price, but they would at least reveal correlations between price swings, volatility levels and trader categories. As a serious supporter of transparency, the CFTC should seek these numbers.

Also, regulators should revisit the question - what is "excessive speculation?" Since the passage of the Commodity Exchange Act (United States of America – 1936) excessive speculation on exchanges has been prohibited, but not defined. Indeed, there appear to be no parameters for defining such; daily contract volumes exceeding the underlying crop size, frequent limit up and limit down price moves, wide divergences between cash and futures are today seemingly normal components of price discovery. However, according to a former investment banker:

> *A good definition of "excessive speculation" is the market condition where* non-commercial *interests set the price. This occurs when speculative interests dwarf commercial volume and crowd out commercial transactions at a given price. The textbook belief is that this can never happen on the assumption that commodity prices are extraneous to derivatives market activity, and that there is an infinite supply of capital on both side of the market. Under such a theoretical system, when long speculators push up the price above the "true" level, for example, an adequate number of shorts will come in to stabilize prices. This is clearly an idealized and inaccurate set of assumptions as there is no known "true" price, speculative capital is not infinite, nor is it now neutral (many new entrants, e.g. institutions indexing, have a long bias). In the real world, speculation can be excessive.*[33]

31 Technically only 13 500 can be owned in any one month, so the buy order would have to be split into two different months.

32 22 000 corn contracts equals 110 million bushels or 2.78 million tonnes.

33 Jeff Korzenik: "Fundamental Misconceptions in the Speculation Debate," <http://inefficientfrontiers.wordpress.com/2009/07/29/fundamental-misconceptions-in-the-speculation-debate/>

Speaking before the Senate sub-committee on the effect of massive index fund ownership, Michael Masters stated:

> *Passive investment provides no benefits to the market while it exacts a heavy toll. Investors' desire to turn the commodity derivatives markets into something they are not (namely a valid investment vehicle) must be subjugated to the needs of bona fide hedgers to hedge their risks and discover fair prices.* (Masters, 2008).

Although the entire derivatives industry has at times been labelled "casino capitalism," little debate exists on the global societal detriment of channelling more than a quadrillion dollars[34] away from real investment into an activity that produces no economic growth and is a "zero-sum game." Former Federal United States Reserve Chairman Paul Volcker has deeply criticized the explosive growth of all derivatives trade, dismissing it "as a way of shifting around rents within Wall Street rather than contributing to overall United States of America productivity growth."[35]

Also, now is the appropriate time to investigate how structural change in futures markets, including the migration from pit to electronic trading, has impacted the market structure, a phenomenon completely unknown. Anecdotally, many of the small grain commission firms in the United States of America have been driven out of business owing to price volatility. Price diversion between futures and cash values has caused hedging to become too risky and margin calls too expensive. During 2008, many banks refused to extend credit based on futures volatility and elevators refused to quote bids beyond 30 days. As a result, futures commission merchants report a lack of resting orders in deferred contracts. Under this vacuum, markets can suffer from greater volatility and price spikes as buys and sells "at the market" simply go to daily price limits up or down. It also deters arbitragers which provide an important smoothing function to markets by exploiting the mispricing of calendar and inter-commodity spreads. Locals also are absent to smooth out the spikiness of large sized orders. Theoretically – it may be that the new structure of trade has become highly asymmetrical – divided by relatively small hedgers and speculators on the one hand and large non-commercial institutional players on the other. Indeed – the CFTC's report on the open interest percentages shows a large amount of long- and short-ownership by 8 or less traders raising the question of "concentration." Although published without regard to trader type, the COT reveals in wheat, for example, that 37 percent of the long open interest and 24 percent of the short open interest are controlled by 8 or less traders, challenging Adam Smith's capitalistic notion of the multitudinous "invisible hand."

Addressing volatility

In addition to providing greater transparency to transactions, exchanges - which to date have relied on both position limits and price limits - could also consider several new approaches to address volatility.

Limit the size of market orders entered within a particular time period. Although the investigation is still ongoing, the stock market "flash crash" (May 2010) in which the United States of America based Dow Jones Industrial Average (DJIA) dropped about 1 000 points in a matter of minutes is thought to have been triggered by large sized orders entered in rapid succession. As the market dropped

[34] The Bank for International Settlements has reported that the notional amounts of exchange traded derivatives has topped over a quadrillion dollars since 2006.

[35] See: http://www.ft.com/cms/s/0/49e72392-ec3d-11de-8070-00144feab49a.html#axzz179YidQKa.

precipitously, many technical trading systems - based on complex mathematical models which now dominate stock exchange trading - automatically cancelled outstanding buy orders. The resultant vacuum in the buy-side of the market sent the DJIA into free fall. Futures exchanges, having allowed order sizes to increase dramatically over the past twenty years should re-examine the appropriate size of at-the-market buy and sell orders. Instead of allowing one speculator to enter an order that could be as large as 22 000 contracts of corn for example, perhaps they should consider a time-lagged sequence of order entry – one which will not overwhelm the entire system at any point in time.

Ban high frequency trading. High frequency trading (HFT) - which probes the exchange order book - is counter to the price discovery function of futures markets and should be banned. Price discovery occurs when two traders find an equitable mutual price at which they are willing to exchange goods. HFT uses superior technical capabilities and speed to gain insights into the order books of the marketplace and then trade "in front" of these orders – an illegal practice called front running. A CFTC editorial recently stated that HFT needed "reining in," commenting that "parasitical trading does not truly contribute to fundamental market functions." [36], Unless exchanges can demonstrate that HFT benefits the risk transfer and price discovery process of futures markets, it should be banned.

Apply spot month limit positions for longer time period prior to delivery month. Under today's rules, speculators must reduce the size of their positions to 600 contracts (all United States grain commodities) before the first notice day of the contract – the day when sellers tender their intentions to the clearinghouse to make physical deliveries against their short positions. In the CBOT July wheat contract, speculators must reduce their long or short position from, for example, from 4 000 contracts to 600 contracts before June 30 – the July contract's first notice day. The position reduction and the associated extensive amount of rolling, particularly by long index funds (in this example – the roll is executed by selling July wheat and buying September wheat), has tended to create distortions between the spot and following month.[37] The exchanges should consider whether this reduction might be undertaken two to three months prior to first notice day to smooth out this rolling process.

Settle contracts every month – either by delivery or cash. Because futures prices anticipate forward events, prices can trade at wide divergences to cash values in between delivery periods which may occur only 4 to 5 times a year. Delivery – or cash settlement every month – would cause continuous convergence of cash to futures in the front month contract.

Allow shipping certificates or warehouse receipts to expire within one year of issuance. Because of the steep contango - also called "carrying charge" - in some markets, taking delivery of spot month (by warehouse receipt [WHR] or shipping certificate [SC]) and selling the next month allows firms in some instances to earn around 3 percent on their principal after storage and insurance are deducted.[38] The wide contango – has transformed commodity instruments into short- to medium-term financing arrangements and has hindered the movement of grain in and out of the delivery market. If exchanges wanted to force the grain back into commercial channels, it could limit the life of these instruments to one year. Thus holders of expired WHRs or SCs would have to sell the grain represented by the expired instruments to a willing cash buyer.

Reduce position limits. The CBOT increased its limits over a twenty year period from 600 contracts to 22 000 (corn), 10 000 (soybeans) and 6 500 (wheat). The total tonnages of these limits are colossal, as illustrated in Table 13.1. Relatively small limits exist for the same or similar contracts at Euronext

[36] Bart Chilton, CFTC Commissioner, "Rein in the Cyber-Cowboys," Financial Times, Sept 6, 2010.

[37] Much discussion has surrounded the index funds' position roll in wheat; as of November 2010, index funds constituted a long position of about 30 million tonnes against a crop size of about 10 million tonnes. The massive roll – selling spot month and buying the next month is confined by each fund's prospectus to a few days prior to first notice day and has tended to push the spread between spot and next month to the cost of full carry – i.e. the cost of storage, insurance and finance. In November 2010, the Dec/Mar wheat spread traded at a record cost of carry of USD 0.40 per bushel – in other words the December contract was USD 0.40 discount to the March. (Discussed further in Chapter 21)

[38] See CFTC Agricultural Advisory Committee Meeting August 5, 2010 - http://www.cftc.gov/ucm/groups/public/@newsroom/documents/speechandtestimony/aac080510_aulerich.pdf for explanation of this.

Table 13.1: CME Group (CBOT) agricultural positions limits – number of contracts and metric tonne equivalent

Contract	Spot month	Single month	All months
Corn	600 (76.2 thousand tonnes)	13 500	22 000 (2.79 million tonnes)
Soybeans	600 (81.6 thousand tonnes)	6 500	10 000 (1.37 million tonnes)
Wheat	600 (81.6 thousand tonnes)	5 000	6 500 (890 thousand tonnes)
Rice	600 (54.6 thousand tonnes)	1 800	1 800 (163 thousand tonnes)
Oats	600 (51.6 thousand tonnes)	1 400	2 000 (170 thousand tonnes)

Table 13.2: Euronext LIFFE agricultural positions limits – number of contracts and metric tonne equivalent

Contract	Spot month	All months
Milling wheat	2 000 (100 thousand tonnes)	4000 (200 thousand tonnes)
Rapeseed	1 200 (60 thousand tonnes)	2400 (120 thousand tonnes)
Corn	1 200 (60 thousand tonnes)	2400 (120 thousand tonnes)
Cocoa	None	None
Coffee	None	None
Sugar	None	None

Note: Trading Facilities in the European Union – such as commodity futures exchanges - fall within the scope of the Markets in Financial Instruments Directive (MiFED). Although MiFED's trade transparency requirements do not cover derivatives trading, MiFED does allow Member States under Recital 46 to extend transparency requirements to financial instruments such as derivatives. In addition, commercial commodity firms are largely exempt from the reporting requirements applied to investment firms when transacting on regulated markets. MiFED does not address position limits in commodity futures.

LIFFE and these contracts are gaining rapidly in open interest reportedly because their pricing is highly correlated with underlying cash values (see Table 13.2). CBOT needs to re-examine its position limits in the agricultural complex.[39]

Increase margins. Although controversial because high margins dissuade legitimate hedging, raising margins can reduce the leverage within the system and help control volatility. In November 2010, China's Zhengzhou Exchange and Dalian Exchange, concerned about the "price inflation" caused by excessive speculation in its markets, raised margins in several food commodities and saw an immediate decline in prices.

Finally, the exchanges could create entirely new contracts that represent the world pricing system more fairly and completely than current contracts which are ultimately domestic pricing mechanisms (discussed in Chapter 21).

[39] After the July 2010 "corner" on Euronext LIFFE cocoa contract, a German cocoa association warned the exchange that the market had become disorderly; adding - that unless the exchange changed its rules and regulations, it would consider switching its business to the InterContinental Exchange which had strict enforceable limits on cocoa contract ownership and rules against market manipulation.

Conclusions

> *One man's crust of bread is now a rich man's securitized asset class.* (former CBOT trader)

Throughout history, speculation has been strictly circumscribed or prohibited because of its market distorting effects and its disruption to the social order. For a variety of reasons, speculation and modern-day speculators have gained increasing respectability, particularly in the United States of America. An over abundance of food and dwindling numbers of agriculturalists have banished the millennial-old concerns of hoarding and shortages in the richer nations. Also, owing to the enormous profitability of commodity linked products, banks and other traders have waged a successful public relations campaign, surmounting criticism traditionally associated with speculative activities. The creed of free market orthodoxy, defining agricultural markets as just another set of institutional arrangements to be gainfully exploited, has also stifled any debate over the morality of food profiteering and the effects upon the poor. Finally, aided by an admiring "celebrity conscious" media, speculators have ascended to a savvy venerable class, able to amass fortunes at the push of a button.

A deep fissure divides the world's rich and poor. The IMF World Economic Outlook (2007) reports that, in the past 20 years, the effective global labour force quadrupled, which has put downward pressure on wages – in both rich and poor countries, and has created a life threatening hardship in the least developed ones. Conversely – owners or controllers of capital have never had so many opportunities to enrich themselves. Almost nothing is taboo[40] on the trading menu: leveraged bets on corporate debt repayments (credit default swaps), life expectancy (mortality bonds) and of course – the price of food. Largely insulated from failure, today's institutional mega-traders can manoeuvre from one "hot sector" to another, with zero regard to ethical considerations.

Some voices have come forward to say the system has gone awry. The renowned trader George Soros has opined:

> *[...] every speculation is rooted in reality... Speculators create the bubble that lies above everything. Their expectation, their gambling on futures help drive up prices, which is especially true for commodities. It is like hoarding food in the midst of a famine, only able to make profits on rising prices. That should not be possible.*[41]

Several emerging commodity futures markets which appear to enjoy a balance of hedgers and speculators prove that agricultural futures can reduce transaction costs, aid income realization and improve rural welfare, and as such are significant drivers of agricultural development. While speculation is crucial to proper functioning markets, unlimited speculation is not. As the prices broadcast from the major exchanges, particularly the CBOT, reverberate around the world and affect billions of lives, a serious and more directed inquiry into the trading on the international commodity futures markets should commence. Only a new methodological approach – one that analyses orders and transactions, segregated by trading types - can start to separate fact from fallacy.

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40 The CEA prohibits the listing and trading of event futures contracts based terrorism, assassination, war and gaming.

41 George Soros interview with Stern magazine, July 3, 2008.

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Chapter 14

The economics of information and behaviour in explaining excess volatility

Adam Prakash and Matthieu Stigler[1]

> *So long as economists were content to regard the economic system in a static fashion, it was reasonable to treat it as a self-righting mechanism... As soon as we take expectations into account, the stability of the system is seriously weakened... it is henceforth not at all surprising that the economic system of reality should be subject to large fluctuations.* (Hicks, 1939)

Economic agents are continuously required to make decisions in the face of a future that is not yet known. Therefore, expectations play an essential role in the determination of current economic variables. On the other hand, the expectations that agents hold at any time are determined by the information they have at that date on the economic system, in particular on its current and past states. Observed economic processes are thus the result of a strong and complex interaction between expectations of agents involved and the actual realizations of economic variables (Grandmont, 1977). Consequently, the evolution and stability of the price system will depend upon the rules and processes of expectations formation and revision used by agents (Radner, 1991).

The notion of the price system as an information entity was alluded to in Chapter 1. In this chapter, the behavioural dimensions of markets are explored with respect to how expectations are formed when agents possess diverse information and how this might generate excess volatility. There is a host of competing theories of how expectations and trading behaviour influence prices and volatility. Even though many may possess intuitive appeal, the data that would support theoretical mechanisms underpinning behaviour are by and large unobservable, such as expectational processes. Similarly, the notion of "fair" or "fundamental value" which is needed to assess how excessively volatile prices are cannot be deduced. Finally, the electronic marketplace produces instantaneous audit trails of order flow and transactions that are segregated by types of traders, but these are not furnished (FAO, 2010: *special feature*).

As a consequence, measurement issues have thus largely confined the testing of theory to the experimental realm rather than the empirical realm. While these theories show that active trading allows markets to efficiently incorporate information about demand and supply fundamentals, if fundamentals-based trading does not take place, futures markets can act as a distorting lens; they can distort agricultural prices and lead to bubble-type phenomena.

Moreover, traders rely on information about current market fundamentals and on forecasts of future market conditions, but, as Chapters 3 and 4 have shown, there is considerable uncertainty in the sources of shocks, which encumbers signal extraction in

[1] Statistics Division (FAO).

a noisy environment. Traders are required to formulate their expectations about price movements based on partial signals and uncertain data. By focusing on a limited number of available signals, there is a plausible risk of herding by following the behaviour of others, or simply basing trading decisions on trend extrapolation.

Efficient markets, excess volatility and bubbles

The efficient market hypothesis (EMH) has been one of the cornerstones of modern economic theory. EMH has widely been applied in finance and commodity models to explain prices dynamics in competitive markets. Basically, the theory requires agents to form expectations rationally, and whenever new information emerges (e.g. new harvests or stock forecasts) they update their expectations appropriately. Importantly, all agents need not be correct in forming expectations, some may overreact and some may under-react, but as a whole the market is always "right". On average, responses are randomly normally distributed with the result that market prices cannot be readily exploited to earn excess profits. This implies that expected price movements $E[P_{t+1}]$ are governed purely by new information I_t with prices following a random walk:

$$E[P_{t+1}|I_t] = P_t \, E[P_{t+1}|I_t] = P_t \tag{1}$$

In a series of seminal papers, Grossman (1976, 1995) and Grossman & Stiglitz (1976, 1980) identify a paradox within the rational expectations framework and its notion of "fully revealing information equilibria". The authors emphasize the conflict between the efficiency with which markets embody information and the incentives to acquire information: prices cannot perfectly reflect all available information, because if this was so, agents who expend resources in collecting information would receive no return for their efforts, rendering trade redundant.

To resolve this paradox without loosening the tenet of the EMH, Grossman and Stiglitz introduce agents who possess different information traits: those who are informed and those who are uninformed, together with the addition of “noise” to produce ”partially” rather than fully revealing equilibria.

As illustrated in Box 14.1, Grossman (1995) theorizes that there are incentives to directly collect information, to help forecast the dynamic feasibility of people’s plans, and to attempt to profit from their inability to realize their plans. The attempts to profit from collecting information about such feasibility enhances the informativeness of the price system and helps the plans cohere by the transmittal and aggregation of information. In this setting, the rational-expectations equilibrium price aggregates disperse private information, while avoiding perfect revelation due to unobservable supply shocks.

Box 14.1: Informational dimensions of the price system

The Transmission of information by prices: Consider the price p_t of a commodity X, which possesses a random *ex post* return, r_t where $r_t = p_t - p_{t-1}$. The level of r_t depends on a random variable, η_t which can be observed at a cost at $t-1$, and another unobservable random variable ε_t:

$$r_t = \eta_t + \varepsilon_t \tag{2}$$

Where η_t and ε_t are independent normally distributed variables. The quantity η_t can be regarded as a measurement of r_t with error, so that knowledge of η_t does not eliminate the risk associated with the commodity. The demand for X by agents with information on η_t, $X^i_{D,t}$ will depend both on p_t and the value of η_t:

$$X^i_{D,t} = X^i(p_t, \eta_t) \tag{3}$$

Given $\partial X^i_{D,t}/\partial \eta_t > 0$ and $\partial X^i_{D,t}/\partial p_t < 0$ and introducing the demand by uninformed agents denoted as $X^u_{D,t} = X^u(p_t)$, equilibrium requires:

$$\lambda X^i_{D,t}(p_t, \eta_t) + (1-\lambda) X^u_{D,t}(p_t) = X_{S,t} \tag{4}$$

where $X_{S,t}$ is the supply of the commodity and γ represents the fraction of informed agents trading in the particular market. Uninformed traders observe only p_t, but from p_t they may be able to infer η_t. To see this, assume that $X_{S,t}$ is fixed. Uninformed traders can infer that a higher p_t is associated with a higher η_t, as an increase in η_t increases $X^i_{D,t}$ and hence p_t. In the absence of any other stochastic elements in the model, the conditional distribution of r_t given p_t is the same as the conditional distribution of r_t knowing η_t. Consequently, the price system conveys all the information from the informed to the uninformed.

The Aggregation of information by prices: Consider a market for a commodity, in which the price at period $t+1$, p_{t+1} depends on the information received by n informed traders ($n > 1$). Assume that the *ith* trader observes some signal, ϑ_i where $\vartheta_i = p_{t+1} + \varepsilon_t$. The stochastic term ε_t prevents any single trader from ascertaining the true signal from p_{t+1}. The current price p_t is a function of the observed information of the different traders, $p_t(\vartheta_1, \vartheta_2, \ldots, \vartheta_n)$ and reveals more information to each trader than each is initially endowed with. That is, the price system aggregates all the market's information in such a manner that p_t is a sufficient statistic for the unknown value of p_{t+1}. A trader who divests no resources in gathering information can achieve a similar return to those traders who pay for ϑ_i. In a similar vein, a trader who purchases ϑ_i and then observes $p_t(\vartheta)$ where $\vartheta = \vartheta_1, \vartheta_2, \ldots, \vartheta_n$, finds that $\vartheta_i$is redundant; $p_t(\vartheta)$ is superior to ϑ_i, reflecting all necessary information, and can be obtained without cost.

Noise: The above asserts that the price system aggregates and transmits information perfectly, and equilibrium is in this instance fully revealing: price reveals to each trader the information acquired by all traders. However, under conditions in which either the demand or supply is stochastic, a rise in price might again be owing to a higher η_t, but a higher p_t might also arise from an increase in $X^i_{D,t}$ or a fall in $X_{S,t}$. Hence, for any observed p_t there is a distribution of possible values of η_t

Source: Grossman & Stiglitz (1980).

Yet another controversy was also identified with the EMH, but this time the issue concerned empirical observation. Shiller (1981) and Shiller (1990) provided statistical evidence showing volatility in the equities market to be "excessive" over and above that which is predicted by efficient market theorists. Despite their claim that the EMH can explain sudden and unexpected price movements as a result of new information (e.g. expected earnings), Shiller's argument is that fluctuations are far too large - some five to thirteen times higher - to be attributable to mere changes in information. He postulates that the observed excess volatility is a result of psychological beliefs that exert a greater influence on the market than do economic fundamentals.

There is now substantial evidence that stock prices are more volatile than should be expected if they were equal to the present value of a rational expectation of future dividends (Gilles & LeRoy, 1991; Bulkley & Harris, 1997). However, there is little consensus about why prices appear to be excessively volatile. In addition to Shiller's thesis, Bulkley and Harris survey a number of competing explanations: one explanation, consistent with the EMH, is the argument that there may be rational bubbles in stock prices (West, 1988; Flood,

1990) or that price movements may be explained by market frictions (Weil, 1989). The authors hypothesize that somewhere in between these two extremes is the possibility that markets may incorporate new information into prices, but not in expectations of future returns as agents simply use irrational and inappropriate mechanisms to forecast returns by overreacting to current information (see deBondt & Thaler, 1985).

If expectations, rational or otherwise, are driving departures from fundamental values, a major problem in testing competing hypotheses concerns the fact that expectations cannot be observed, as discussed in Box 14.2.

Box 14.2: Limitations in identifying bubbles

At this stage in the development of economic theory, the rational bubble hypothesis can be regarded as devoid of empirical content. The main reasons are that we do not observe expectations, and we cannot exclude other, entirely rational, non-bubble alternative explanations of prices. The theory "provides no clue" about the conditions initiating or terminating bubbles. One reason that a bubble hypothesis is difficult, if not impossible, to test is that expectations are measured relative to some maintained hypothesis and, with rational expectations, exploit all of the information that is relevant according to the maintained hypothesis. Bubble phenomena are what remains unexplained by the hypothesis. In this sense, bubbles are a name assigned to phenomena that may be explained by an alternative hypothesis.

There are other ways of modelling expectations that remain consistent with rational expectations and full use of available information but do not involve bubbles. Suppose that the process governing asset prices or other variables is:

$$x_t = A_t e^{\alpha(t)} u_t \quad (5)$$

where t is time, A, α and u are random walks with zero mean and constant variance.

Instead of a single random shock with zero mean and constant variance, let's assume that asset prices (or other variables) are subject to three types of shocks, each with zero mean. First, there are transitory, random deviations around a fixed trend or stationary value (u_t). This is the familiar random walk. Second are permanent changes in level, ΔA_t, and third are permanent changes in growth rates, $\Delta\alpha_t$. Investors cannot observe the errors directly, and cannot separate them initially and for some time after. They can only infer from a series of observations whether the level has changed permanently, thereby temporarily altering the measured growth path. A single observation does not permit the investor to know whether a current change is a temporary deviation that will revert to the prior mean, a persistent change that permanently changes the mean level but not the growth rate, or a permanent change in the growth rate.

If the variance of the transitory component is relatively large, several observations are required for modest confidence that a change in the mean is permanent. And additional observations may be needed to decide whether the mean will continue to change, i.e. that the observed change is a change in growth rate and not a permanent change in level. Series like profits, stock prices and productivity are examples of relatively noisy series. After five years of productivity growth above the average or trend of the previous twenty years, we can only guess whether there has been a permanent change in trend productivity growth and profits, in one but not the other, or in neither. The length of time needed to gain confidence about the permanence of the change depends on relative variances of transitory and permanent shocks.

As a model of asset prices, this model differs from the bubble model. It views the investor as using incomplete and noisy information to infer the future path of profits and asset prices. Investors or speculators do not trade mainly on noise. They try to infer future patterns or trends and they pay for the services of professional letter writers and advisers, or the services of professional investors, who use different types of models and procedures to reduce not just risk but uncertainty. They hire economists to forecast the future because, despite the mediocre record of such forecasts, they are the best forecasts available.

Unlike the rational bubble model, in this model expectations are based on imperfect knowledge of future fundamentals such as profits. Unlike the irrational exuberance model, systematic changes in fundamentals are critical. Investors and speculators may grossly overestimate (or underestimate) future profits and dividends, but they rely on their imprecise knowledge of the future and correct, or perhaps over-correct, when new information becomes available.

Source: Adapted from Meltzer (2002).

Rational bubble models assume that in spite of the market's full cognizance of an asset's fundamental worth, investors may be willing to pay more than this value. If the rational expectation of future price growth is large enough to assure a normal rate of return, a rational bubble may be perpetuated. However, in order for the bubble to be sustained, price must grow at a rate faster than perpetual returns.

Shiller (2003) also depicts a simple and intuitive feedback mechanism that permits (irrational) bubbles. His "irrational exuberance" model of behaviour posits that if prices of an asset begin to rise, positive returns by incumbent investors fuels the spread of over-enthusiasm in the market, attracting public attention. New (uninformed) investors then enter the market and start to bid up prices. As investors extrapolate price rallies into the future, it feeds the expectation of further price increases, drawing in new players. In describing Shiller's bubble model, Lansing (2007) states "the market's meteoric rise is typically justified in the popular culture by some superficially plausible 'new era' theory that validates the abandonment of traditional valuation metrics". However, just as upward price motion can be set forth, the onset of pessimism and can lead to a collapse in Shiller's bubble.

At the heart of Shiller's feedback model is the prediction that investors chose naive price extrapolation rules over above fundamental-based rules. In a similar vein, Lansing (2006) shows that by "locking-in"[2] to a extrapolative forecast rule will likely follow if other investors are following the same approach. From the viewpoint of an individual investor observing an upward sustained trend, switching to a fundamentals-based forecast would appear to reduce forecast accuracy, so there would be no incentive to do so.

In addition to positive feedback trading and trend extrapolating, there is a host of other behavioural theories that support the rejection of the EMH in explaining excess volatility. Most concentrate on irrationality on the part of uninformed traders who base trade on current and past price movements *vis-á-vis* their informed counterparts who are more cognisant of fundamentals in their transactions.

Uninformed traders observe price movements but cannot distinguish whether signals relate to noise or changing fundamentals. Hence, without acquiring information, they run the risk of incorporating noise signals into their trading strategy and perpetuating the broadcast across the market. Uninformed traders are prone to following "momentum strategies"[3] of buying commodities that have experienced rising prices and selling those that have underperformed.

If one can detect momentum trading, changes in positions can be anticipated offering arbitrage possibilities. De Long et al. (1990) report that traders employed by financial institutions will engage in momentum trading to meet their institutions' short-term

[2] Lansing (2006) uses the concept of "locking-in" as an irrational choice among competing technologies, as chance events or "historical accidents" may cause people to initially choose, and then stick with, an inferior technology. Extrapolative rules can be viewed as an inferior technology because market predictions would improve if all investors could be induced to switch to a fundamentals-based approach.

[3] However, subsequent research by Crombez (2001) that by augmenting factor pricing models with additional factors, momentum can be observed even with perfectly rational traders.

performance targets, even if doing so implies going against signals from long-term fundamental supply and demand factors.

Barberis et al. (1998) demonstrate that current good (bad) news has power in predicting positive (negative) returns in the future. Evidence shows that over longer horizons, equity prices overreact to consistent patterns of news pointing in the same direction. This is in support of Kahneman and Tversky's (Kahneman & Tversky, 1979) over-reaction hypothesis that individuals tend to overweigh recent information and underweigh past information, which is in violation of the Bayesian principle that predictions must be moderated by consideration of their probability of occurrence.

Daniel et al. (1998) propose a unified theory of "overconfidence, self-attribution, and security market under- and over-reactions" based on investor psychology to explain anomalous departures from the EMH. Their theory is premised on two behavioural attributes. The first is that traders are overconfident about their ability to evaluate sentiment by overestimating the importance of their private information signals.The second is that confidence changes in a biased fashion as a function of their decision outcomes. The authors show that the first premise implies overreaction to private information arrival and under-reaction to public information arrival, giving rise to excess volatility in prices, while the second premise leads to momentum-type effects.

Relevance to agricultural commodity markets

It may appear confounding in relating the relevance of the foregoing discussion with price behaviour in agricultural markets. Traditionally, agricultural commodities have been looked upon as a poor investment because, owing to the tendency of their prices to fall historically in real terms - as a result of productivity growth and falling marginal costs - they have a negative rate of return. Consequently, prices of commodities have not had the propensity to keep up with overall inflation.

However, as discussed in Chapter 3, agricultural commodities (including food products) have recently attracted investment as a store of wealth that potentially varies inversely with the inflation/deflation effects on monetary assets. In other words, as equity and bond returns decrease, there is a tendency for commodity returns to rise as inflation increases. Investors have thus identified commodities as an "asset class" and see portfolio diversification advantages in adding a proportion of commodity futures to equity and bond portfolios. They set out to replicate an index or a sub-index of one of these as shown in Table 14.1.

The influx of money towards tracking these indices has experienced enormous growth: in the period from the end of 2003 to March 2008, investments in commodity index funds increased from USD 13 billion to USD 260 billion, and the prices of the 25 commodities that compose popular indices (the Standard & Poor's Goldman Sachs Commodity Index and the Dow Jones - AIG Commodity Index) had risen by an average of 183 percent in those five years.[4] However, such investment in commodity derivatives does not pay interest, rents, dividends, or entitle the holder to a share of a company's future cash flow. Therefore, the only return that can be expected is a favourable change in the price of the contract[5] and for this reason, buying commodities futures is considered speculation and not investment (Masters & White, 2008).

4 See Shedlock: "Quantifying Commodities Speculation, MISH'S Global Economic Trend Analysis" <http://globaleconomicanalysis.blogspot.com/2008/05/quantifyingcommodities-speculation.html>.

5 After the cost of carry is deducted.

Table 14.1: Traded commodity indices

	Reuters/ Jefferies CRB Index (RJ/CRB)	Rogers International Commodity Index (RICI)	Dow-Jones-AIG Commodity Index (DJAIG)	S&P Goldman Sachs Commodity Index (SPGSCI)	Deutsche Bank Liquid Commodity Index (DBLCI)
Launch date	1957, rev. 2005	1998	1998	1991	2003
New York Board of Trade (NYBOT)				**Chicago Mercantile Exchange (CME)**	
No. Components	19	36	19	24	6
Agriculture	8	18	6	8	2
Livestock	2	2	2	3	0
Agriculture weights (%)					
2005				11.16	
2007		31.9	30.2	13.1	22.5
2008	34	31.9	28.43	12.58	22.5
2009	34	31.9	29.23	17.65	22.5
2010			29.5	13.7	
Livestock weights (%)					
2005				4.66	
2007		3	9.2	5	
2008	7	3	8.5	4.16	
2009	7	3	6.65	6.37	
2010			7.4	5.24	

Source: Zawojska (2010).

As investment interest in commodities rises, it is natural to ask whether shocks from conventional asset markets rather than underlying commodity market fundamentals may weaken the diversification value of commodities (Silvennoinen & Thorp, 2010). The authors assert that macroeconomic fundamentals may increase commodity futures correlations with other assets via common drivers such as interest rates and spreads, and expectations of future world growth. Interestingly, Tang & Xiong (2010) have shown that agricultural commodities have begun to behave more and more like the energy commodities they are indexed with.

Indeed, index traders behave like noise traders: they change their total positions in commodities based on information signals relating to other asset markets of no relevance for commodity markets which can give rise to momentum trading strategies. In addition, index traders, though maintaining a commodity's predetermined weight in the index, may change the composition of their positions in response to price changes for different commodities. This makes it difficult for other traders to judge whether market prices are changing because of the position changes of the noise traders or as a response to new information about market fundamentals (UNCTAD, 2009).

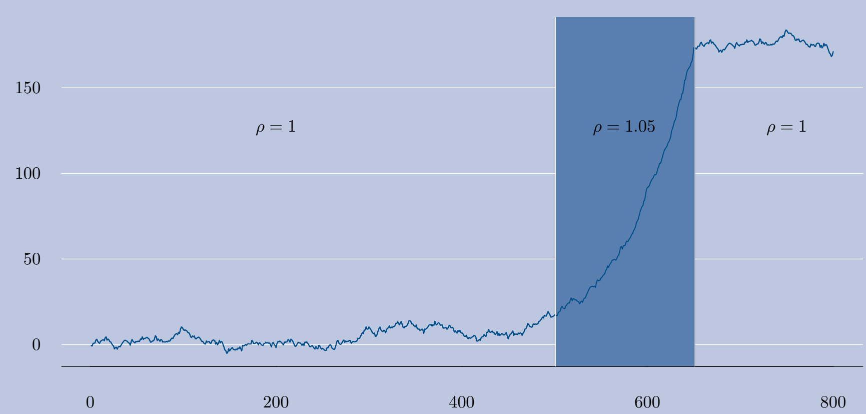
Index traders may also take position changes that are so large relative to the size of the market that they move prices. This is commonly referred to as the "weight-of-money" effect. Again, by assuming index-weighted positions across commodity portfolios, large positions can present weight-of-money risks.

In the face of short-run price inelasticity in both production and consumption, physical adjustment mechanisms of markets are weak and can magnify weight-of-money risks. This is particularly true when physical inventory levels fall, in which case the relevance and determinacy of expectations based on longer-term fundamental factors sharply declines (UNCTAD, 2009). "This indeterminacy allows weight of the speculative money to determine the level of prices" (Gilbert, 2008). As a consequence, the traditional mechanisms - efficient absorption of information and physical adjustment of markets - that have normally prevented prices from moving away from levels determined by fundamental supply and demand factors have become weak in the short term, thus heightening the risk of speculative bubbles occurring.

Box 14.3: A bubble in the wheat market?

Statistically, the notion of a bubble is based on the properties of explosive time series. This necessarily implies the root of an autoregressive (AR) process being higher than the value of one, which reflect compounded over-reaction in past values. This can be seen from Figure 14.1, which shows the path of a series where the AR(1) coefficient is unity in the first period, 1.05 in the second and unity again in the third period. A very small change in the AR(1) coefficient is shown to induce a very large change in the dynamics of the data generating process.

Figure 14.1 Simulated series with explosive root

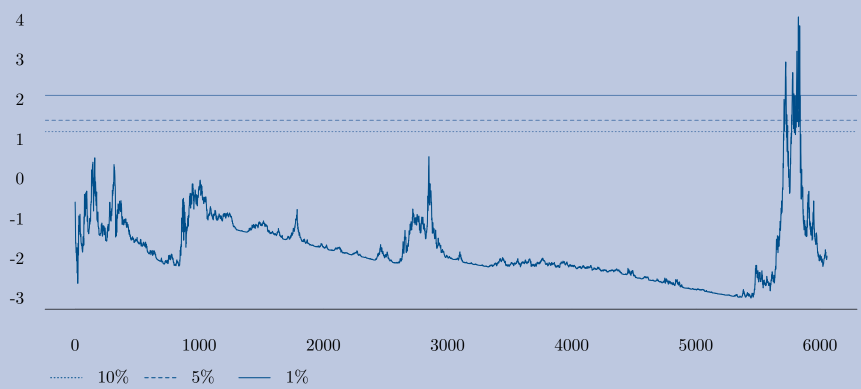


An influential study linking bubbles and statistically explosive behaviour is provided by Diba & Grossman (1987) who investigated bubble formation in asset prices by applying unit root tests to differenced prices and dividends, as well as in cointegration tests. The rationale of applying these tests on differenced values is that according to the authors, if a series is explosive, a unit root test would not be rejected: not only for the levels of the series, but also for the differenced series. Those results, however, were challenged by Evans (1991), who showed by simulation that this procedure had very low power in the case of a periodically collapsing bubble.

To address Evan's criticism, the literature has now focused on models with AR dynamics that change over time. Different models are available for this purpose. Waters (2008) for instance uses a stochastic explosive root framework, while Hall et al. (1999) employ Markov-Switching unit root tests. Furthermore, Phillips et al. (2009) propose a simple recursive unit root test.

We focus on wheat futures prices from CME with a constant maturity of 100 days. The data are shown in Figure 14.2 and are derived on the methodology discussed in Chapter 2 for constructing synthetic futures series. We then perform the recursive ADF test as well as the Markov-Switching test. Turning to the former, we employed the procedure outlined in Phillips et al. (2009) who provide a test based on the recursive ADF test statistic, denoted sup-ADF. Results are shown in the Figure 14.2 below, where it is seen that the null of a random walk is strongly rejected towards explosive behaviour. Interestingly, the period of explosive behaviour corresponded quite closely to the 2006-08 event (starting end of August 2007, finishing 3-4 April 2008).

Figure 14.2 Moving DF test on wheat futures prices



To ensure the robustness of these results, we employ a second method advocated by Hall et al. (1999). These researchers used Markov-Switching AR processes, allowing a distinction between different regimes (for more information see Chapter 16). Again, there appears evidence in favour of explosive behaviour as shown in the following table:

Table 14.2 Markov-switching AR model

	Estimate	Std. Error	t value	Pr(>|t|)
$const_1$	11.01	0.38	28.67	< 2.2e-16
$const_2$	-10.85	0.39	-28.11	< 2.2e-16
ρ_1	0.97	0.00	940.37	< 2.2e-16
ρ_2	1.03	0.00	1003.96	< 2.2e-16
σ	5.83	0.06	101.68	< 2.2e-16
p11	0.55	0.03	17.37	< 2.2e-16
p22	0.49	0.03	17.54	< 2.2e-16

It is seen that the AR coefficient in the second high regime (ρ_2) has a value of 1.03 and there is a high probability (49 percent, see parameter p22) of remaining in that regime.

Econometric evidence the role of non-commercial speculation

One of the main reasons that opinions are so divergent about the role of commodity investment in generating excess volatility and prices departing from fundamental value has to do with the econometric methods used to substantiate claims. The primary tool at the econometrician's disposal, which has been applied prolifically in the debate, is the Granger causality test (see Box 14.4). For instance Gilbert (2009) found evidence of a significant relationship between index fund trading activity and returns in several commodity markets. By contrast, Irwin & Sanders (2010) applied the test framework and concluded that there is "mild evidence of a negative relationship between index fund positions and the volatility of commodity futures prices, consistent with the traditional view that speculators reduce risk in futures market and therefore lower the cost of hedging".

Because the Granger causality test is prone to model selection bias as well as small sample bias, it is not surprising that results from these tests can be used to reject competing hypotheses. In addition, Pagan & Schwert (1990) and Phillips & Loretan (1990) have shown that transaction data on commodity exchanges are far too volatile for Granger-type tests to be meaningful.

Box 14.4: Testing the influence of variables - Granger causality

In a seminal paper, Granger (1969) developed a time-series data based approach to assess the directional influence of one variable to another, which has since become known as Granger (non)-causality. The approach is simply the following: x is a cause of y if it is useful in forecasting y. "Useful" here means that x is able to increase the accuracy of the prediction of y with respect to a forecast, considering only past values of y. Formally, given an information set $\Omega_t$with the form $\left(x_t,\ldots,x_{t-j},y_t,\ldots,y_{t-1}\right)$, one can say that x_t is Granger causal for y_t with respect to Ω_t if the variance of the optimal linear predictor of y_{t+h}, based on t, has smaller variance than the optimal linear predictor of y_{t+h} based only on lagged values of y_t, for any h. Thus, x Granger-causes y if and only if $\sigma_1^2\left(y_t : y_{t-j},x_{t-i}\right) < \sigma_2^2\left(y_t : y_{t-j}\right)$, with j and i = 1, 2, 3, . . . ,n and σ^2 representing the variance of the forecast error.

In spite of its name, true causality cannot be inferred from Granger causality testing. If both x and y are driven by a common third process with a different dynamic order, inference from bi-directional tests could be reversed.

An enquiry into the destabilizing impact of momentum traders

In technical analysis, a charted price trend resembles a cup with a handle. It occurs when the price of a security reaches a high and then takes a U-shaped downtrend and uptrend. This is the cup. When the price approaches its previous high, investors who bought at or near the previous high tend to sell their shares, which causes the price to drop slightly. This is the handle. After the handle "completes", the price of the security tends to increase significantly. Technical analysts view cups and handles as buy signals under the correct circumstances.[6]

As discussed above, the causal link between speculative activity and price movements has been criticized on grounds that causation might be subject to reversal. However, the traditional view that increased speculation should bring about price stability might be questioned given the influx of new types of traders on organized markets. In this section,

6 Definition on Internet http://financial-dictionary.thefreedictionary.com/Cup+and+Handle.

we investigate the issue more closely, examining how the interplay between so called technical/chartist and fundamental traders can potentially have a role in influencing prices.

It is important to clarify the different connotations typically associated with the term "speculation". A distinction that is usually made is based on the United States' Commitment of Traders (COT) report, in which commercial and non-commercial traders are separated out. This distinction has potentially important implications for price discovery and underpins the theoretical literature on price determination, namely the competitive storage model (Williams & Wright, 1991 and Deaton & Laroque, 1992). The underlying notion of this model is that storage decisions by commercial traders smooth prices by taking quantities off markets when harvests are abundant. In such instances, speculation is found to have a stabilizing effect. Price spikes occur when speculation has ceased and there are stock-outs.[7]

A further distinction that was made at the beginning of this chapter and in Chapter 3 concerns fundamental and technical (or momentum) traders. Fundamental traders are defined as traders with a deep knowledge of the market, which allows them to form an informed judgment on fundamental value. Hence, when traded prices depart from perceived fundamental value, fundamental traders expect that the price will revert to its fundamental value and hence will sell (buy) when the price is too high (low). In contrast, technical traders by definition trade according to rules that mostly amount to inferring statistical tendencies and anomalies from the data. Typically, they tend to reinforce prevailing market trends.

There is a large amount of evidence that confirms the active participation of technical traders on markets and an equally sizeable body of theoretical literature on their influence (see Easley et al., 2008). As early as 1950s Working (1953) developed a model in which traders are divided into two groups: those who are well-informed and skilful and those who are ill-informed and unskilled. Zeeman (1974) presented a model of catastrophe, theorizing how volatility could occur in an environment with fundamentalist and trend-following technical traders when the latter are sufficiently influential to impact markets. Day & Huang (1990) and De Grauwe et al. (1993) have shown that chaotic dynamics can arise in models with fundamentalists and chartists when the latter exercise sufficient influence. Farmer & Joshi (2002) find that technical traders can amplify incoming noisy information, alter its distribution, and induce temporal correlations in volatility and volume. Others, such as Chiarella et al. (2008), Taylor & Allen (1992) and Nofsinger & Sias (1999) show similar influence of technical analysis.

De Long et al. (1990) and De Long et al. (1990) demonstrate that noise traders occasionally out-perform fundamentalist traders. Du et al. (2009) employ a sophisticated stochastic volatility model to show that speculation, as measured by the ratio of non-commercial positions to commercial positions, has important impacts on the volatility of oil, and incidentally that there are significant volatility spillovers from oil into maize.

Models

An empirical test of the hypothesis of fundamental versus technical traders applied on commodity markets can be found in the work of Reitz & Westerhoff (2007) and Reitz & Slopek (2009). They model explicitly the two types of agents, under the notion that fundamental traders become more active when the deviation of price from its fundamental value is large.

7 This is contrary to the idea of hoarding, which through storing the commodity in expectation of a price increase, may contribute to price upswings.

The demand by the momentum traders, D^c is modelled as following:

$$D_t^C = a(P_t - P_{t-1}) \tag{6}$$

where the coefficient a indicates how much the momentum traders believe the trend will continue. On the other hand, the demand of fundamental traders, D^F, is assumed as:

$$D_t^F = b(F - P_{t-1}) \tag{7}$$

where F is the fundamental value of the commodity. Fundamental traders are assumed to know the intrinsic value of the commodity, and to intervene on the market when the price is drifting too far from this value, i.e. selling an over-valued commodity, buying an undervalued one. Contrary to momentum traders, their behaviour will have a stabilizing impact on the prices.

Reitz & Westerhoff (2007) add an interesting feature to the model by assuming that the effect of fundamental traders will not be fixed, but will increase when the spread between the fundamental and actual value of the commodity increases. In other words, the more the price departs from its fundamental value, the more traders will follow a fundamental strategy. To model the fact that the variable's impact increases depending on its is own level, they use the Smooth Transition Autoregressive (STAR) model (Terasvirta & Anderson, 1992), with the transition function W_t, indicating the impact of fundamental traders in the market[8], that evolves accordingly to the logistic function:

$$W_t = \frac{1}{1 + exp\left(-c\frac{|F-P_t|}{h_t}\right)} \tag{8}$$

W_t takes values between 0.5 and 1. c is the so-called slope parameter of the logistic function, which indicates how smooth the transition from 0.5 to 1 is. Figure14.3 shows the value the value of W_t for different values of c.

The value h_t corresponds to the conditional volatility measure obtained from a GARCH model:

$$h_t = \beta_0 + \beta_1 \epsilon_{t-1}^2 + \beta_2 h_{t-1} \tag{9}$$

With the addition of the GARCH equation, the model is now a STAR-GARCH model, introduced by Lundbergh & Terasvirta (1998). An important difference, nevertheless, is that Reitz & Westerhoff (2007) introduce the GARCH term in the mean equation, which makes it a generalization of the ARCH-in-mean (ARCH-M) model of Engle (1982). This can be interpreted as the effect of volatility on perceptions of the fundamental gap. Indeed, in times of high volatility the spread is reduced, and this can be viewed as the difficulty in distinguishing fundamental signals in periods of high volatility.

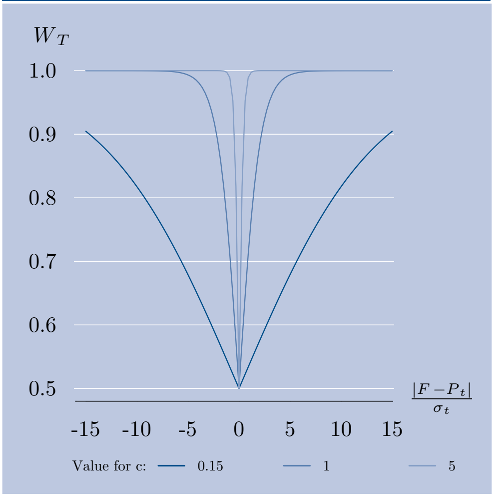
The final version of the model is obtained by assuming that the evolution of the price is given by[9]:

$$P_{t+1} = P_t + d(D_t^C + W_t D_t^F) + \epsilon_{t+1} \tag{10}$$

8 This cannot be properly interpreted as a percentage of fundamental traders, as the ratio of momentum traders is constant in their model.

9 Note that the authors use $\epsilon_t$instead of ϵ_{t+1}, which is obviously a mistake.

Figure 14.3: Logistic function showing impact of fundamental traders



where d is interpreted as a price adjustment coefficient. Inserting the previous equations into (10) leads to:

$$P_{t+1} = P_t + ad(P_t - P_{t-1}) + \frac{bd(F - P_t)}{1 + exp\left(-c\frac{|F-P_t|}{\sigma_t}\right)} + \epsilon_{t+1} \tag{11}$$

For the fundamental value F, Reitz & Westerhoff (2007) use the mean of the price series, based on the fact that the series appear to be stationary, while Reitz & Slopek (2009) use Mainland China's oil imports as a fundamental value in their analysis. The authors apply the model for six commodities, including cotton, soybeans, sugar and rice, and find that the linearity tests in all are rejected and that the coefficient corresponding to bd is significant. They interpret this result as evidence for the presence of fundamental traders, leading them to the conclusion "our model suggest that heterogeneous agents and their nonlinear trading impact may be responsible for pronounced swings in commodity prices".

While innovative, this approach suffers from several drawbacks. Indeed, rewriting equation (11) slightly differently, we obtain:

$$\Delta P_{t+1} = W_t\delta + W_t\beta P_t + \alpha\Delta(P_t) + \epsilon_{t+1} \tag{12}$$

which now corresponds to a STAR version of the usual ADF formulation of the unit root tests, with the smooth effect on the mean reversion and intercept coefficient. Such STAR unit root models have been formally addressed in Kapetanios et al. (2003) and Sollis et al. (2002).

STAR reverting models have been widely applied in different contexts such as testing the purchasing power parity (PPP) hypothesis (Chortareas & Kapetanios 2004, Cerrato & Sarantis 2006), and for hysterisis in unemployment (Yilanci, 2008). Modifications where the transition is abrupt (as in threshold models) have also been applied to similar hypotheses (Bec et al., 2004) and for the interest rate spread (Bec et al., 2008). In the field of agricultural commodities, the STAR model has been employed in the commodity terms-of-trade debate

Figure 14.4: Prices used in modelling momentum

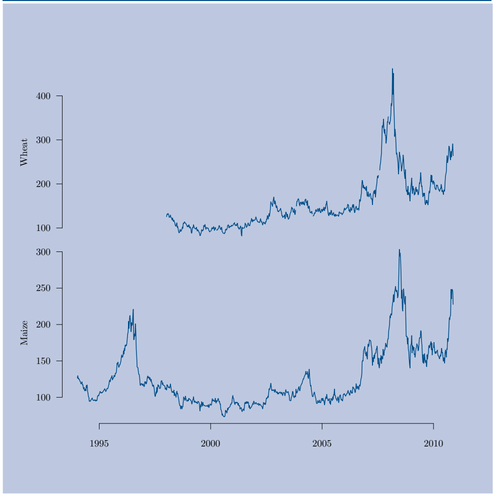


Table 14.3: Summary statistics of wheat and maize price series

	Wheat	Maize	Diff Wheat	Diff maize
Length	662.00	879.00	661.00	878.00
Mean	155.57	126.09	0.21	0.12
Sd	61.69	40.81	9.28	5.71
Kurtosis	1.73	1.44	-0.27	-0.41
Skewness	3.45	1.87	13.88	9.88
AR(1) value	0.99	0.99	-0.09	
DF test stat	-1.35	-1.25	-16.72	-20.33

(Persson & Terasvirta 2003, Balagtas & Holt 2009) and also in the context of spatial price transmission (Goodwin et al., 2008).

It should be noted as early as here that while the results can be interpreted as contributing to the debate on the behavioural dimensions of markets, they may also constitute just a depiction of the nonlinear behaviour of commodity prices. We therefore have concurrent explanations that cannot be disentangled by the present econometric framework.

Data and results

Proceeding nevertheless, we examine behaviour in the CME wheat and maize market. The data, shown in Figure 14.4, are weekly and are taken from FAO. The series start in January 1998 for wheat and January 1994 for maize, and both end in November 2010. Summary statistics of each series are provided in Table 14.3.

Stationarity of the series is examined by applying different unit root tests, including the classical ADF (Dickey & Fuller, 1981), the PP (Phillips & Perron, 1998) as well as the DF-GLS (Elliott et al., 1996), the third test being more efficient in the presence of trends. None of these tests reject the null hypothesis of a unit root in each series at the 10 percent level, although the PP test statistic has values close to this level. In caution, the ADF and PP tests have known low power in the presence of GARCH effects, and this is highly probable in the weekly data. It could be circumvented by simply using a unit root test that accounts for known GARCH effects, such as by Seo (1999), but testing the null against the true alternative of a stationary but nonlinear process, as identified in Pippenger & Goering (1993), would likely improve inference.

We hence use the unit root of Kapetanios et al. (2003), which has the alternative model very similar to (11):

$$\Delta y_t = \rho y_{t-1}\left\{1 - exp(-\theta y_{t-1}^2)\right\} + \sum^p \gamma_i \Delta y_{t-i} + \epsilon_t \tag{13}$$

There are several issues in applying this test to models of the type (11). These mostly concern the treatment of GARCH effects, the nature of the transition function applied (exponential instead of a symmetric logistic), and the treatment of the deterministic term.[10] Leaving them aside, we conjecture that this test is valid for the case in (11).

Employing different combinations of lag orders and deterministic components, we fail to reject a unit root in the maize series, but find a rejection at the 5 percent level for wheat, giving relevance to (11) for this commodity. As highlighted above, the inclusion of h_t (the GARCH component) into the transition function adds a non-trivial complication, as the traditional two-step estimators (mean and then variance) cannot be applied. By resorting to a joint maximum likelihood method, which combines the STAR and the GARCH attributes, estimation of the so-called hyper parameters of the STAR model (the slope component of the transition function), however, was found difficult to implement, as the likelihood function is potentially flat around the slope estimate.

Results for estimating the full model were unsatisfactory, revealing potentially local maxima. We then attempted a simpler version, where the scaling in (11) is achieved by using long-term variance without estimating the GARCH equation. The results using this method are shown in Table (14.4).

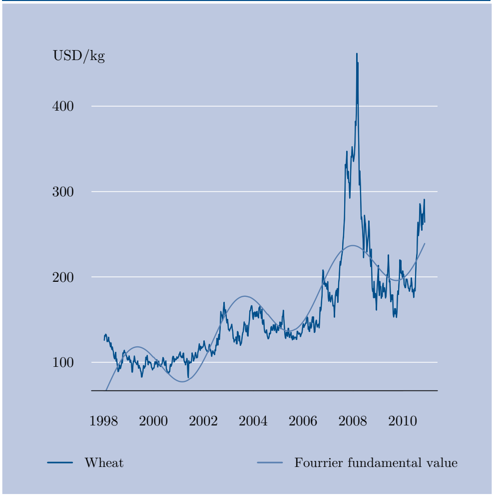
Table 14.4: Parameter estimates from model (11)

	Estimate	Std. Error	t value	Pr(>|t|)
ρ	0.0085	0.0069	1.23	0.2173
γ_1	-0.0816	0.0393	-2.08	0.0381

It is seen that the coefficient on y_{t-1} is very low, and does not appear to be significantly different from zero. This leads us to question the specification of the fundamental value. The notion of the static mean to represent fundamental value is highly questionable, as this presupposes that the fundamental price of wheat has remained constant throughout the period, and ignores the strong likelihood for disequilibria to be present in a weekly series. However, this in turn then raises an important conundrum, namely what is the "fair value" or "fundamental price" of the commodity? One approach would be to resort to theoretical forms underlying price determination as in Reitz & Slopek (2009). Instead, we assume the

10 Here, the constant corresponding to the fundamental value is subtracted before, leading to a demeaned version of the test, with $y_t = Y_t - \bar{Y}_t$.

Figure 14.5: Fourrier fundamental value in wheat price series



fundamental value can be measured by a moving average. By doing so, we acknowledge that fundamentals evolve, but avoid the risk of using a mis-specified proxy for fundamental value.

The estimation of the moving fundamental value could be done in different ways, for instance by using a simple moving average process or through nonparametric methods. We use a Fourier approximation, retaining the low frequency component. This is motivated by the fact that through a Fourier approximation, one can model multiple smooth breaks as well as a slowly moving deterministic component. In addition, Enders & Lee (2009) provide unit root tests that explicitly take these attributes into account. Therefore, the equation to test for fundamental mean reversion is:

$$\Delta y_t = \alpha(t) + \rho y_{t-1} + \sum^{p} \gamma_i \Delta y_{t-i} + \epsilon_t \tag{14}$$

with the deterministic component $\alpha(t)$ modelled as follows:

$$\alpha(t) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \sin(2\pi kt/T) + \sum_{k=1}^{n} \beta_k \cos(2\pi kt/T) \tag{15}$$

There are two versions of the test, one with a single low frequency (between 1 to 5 say) and another that uses the sum of frequencies. We apply the first test to both the wheat and maize series, and confirm the previous results. Figure 14.5 shows the wheat series with its estimated long-term component that we assume as the fundamental value.

We now estimate the model (11) using the fundamental component from the Fourier approximation.

It is now observed that the parameter corresponding to y_{t-1} is significantly higher than what was obtained in the previous model, where the fundamental value simply represented the mean of the series. The t-value is also definitively higher, indicating significance. Being

Table 14.5: Parameter estimates from model (14) with slow moving average

	Estimate	Std. Error	t value	Pr(>|t|)
y_{t-1}	0.0723	0.0207	3.49	0.0005
Δy_{t-1}	-0.0696	0.0391	-1.78	0.0754

very close to zero, the smoothness coefficient, however, is surprisingly low, indicating that that the "fundamental spread" tends to be corrected very slowly.

To come back to the main objective of the analysis, that of identifying the impact of fundamental traders on prices, we find that when including nonlinearities to how agents perceive mispricing, "fundamental reversion" cannot be rejected. This phenomenon is likely to come about from the interplay of both types of traders, indicating that fundamental traders have a stabilizing impact, whereas technical traders do not. This conclusion should be taken with caution, as the findings are potentially consistent with competing theories that deal either with real factors or with behavioural dimensions.

Conclusions

This chapter explored the theory and evidence of the behavioural dimensions of markets, especially how expectations are formed when traders possess diverse information and how these expectations might generate excess volatility. It demonstrated that a multitude of competing and conflicting theories of trading behaviour can potentially influence prices and volatility.

Much of what is conjectured has intuitive appeal, but given that data supporting theoretical mechanisms and underpinning behaviour are unobservable, robust empirical evidence is by and large absent. An important, though fairly self-evident point, is that if "fair price" or "fundamental value" could be observed, it would be straightforward to measure the excess volatility in prices.

Nevertheless, the analysis presented in the chapter employed the notion of fundamental value to show how technical traders can shift prices away from equilibrium, underscoring the importance of fundamentals based trading in stabilizing markets. While this "evidence" may contribute to the debate on the behavioural dimensions of markets, the evidence may equally just confirm the nonlinear statistical properties of commodity prices that other theories have a role in explaining, such as the competitive storage model presented in the next chapter.

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Chapter 15

Storage arbitrage and commodity price volatility

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This chapter is concerned with the role of storage arbitrage in shaping price dynamics. We apply the Pseudo Maximum Likelihood estimator of Deaton & Laroque (1995), corrected for numerical accuracy of the solution function and modified to allow for free disposal of excess stocks, to current series of annual average commodity prices. We confirm the fundamental result of Cafiero et al. (forthcoming) that the standard storage model in the tradition of Gustafson (1958) is indeed capable of explaining the most prominent features of the dynamics of commodity prices, including episodes of isolated price spikes and conditional high price volatility. Using a series of de-trended annual average prices for wheat, we demonstrate how to use the estimated model to generate distributions of the price next period, given the past history of prices and conditional on the amount of stocks implied by the current price. Such information should prove very useful in anticipating periods of high price volatility and in planning policies to prevent turmoil and crises in food markets.

Introduction

Understanding the dynamics of storable commodity prices and how they relate to fundamentals of supply and demand remains a challenge for policy analysts and economists. Episodes of sudden increase in price volatility, not necessarily aligned with detectable contemporaneous shocks in the underlying supply or demand, have significantly challenged the ability of economists to explain price dynamics. The occurrence of food price spikes, in particular, raises concerns for the welfare of the poor and most vulnerable, for whom even short periods of high food prices could have disrupting long-run consequences. Often, irrational speculative-driven bubbles have been blamed for such episodes of high price volatility, with no clear implications in terms of which possible policies could effectively prevent repetition of food price crises.

In this chapter we explore the role intertemporal arbitrage through storage plays in shaping the dynamics of prices by analysing a number of series of international agricultural

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commodity prices, extending to the latest available figures of 2010. Our empirical estimations confirm the practical relevance of a fundamental result of Cafiero et al. (forthcoming), namely, that storage arbitrage is capable of explaining the most prominent features of the dynamics of commodity price, including episodes of isolated price spikes and high price volatility. We show how to use the estimated model to generate expectations of future price given the past history of prices and conditional on the amount of current stocks, a predictive tool that should prove very useful in anticipating possible periods of high price volatility and as an aid in planning policies to prevent food crises.

Moving from the seminal contribution of Gustafson (1958), and the later ones of Samuelson (1971) and of Scheinkman & Schechtman (1983), we consider what is by now referred to as the "standard storage model" (Wright & Williams, 1982; Deaton & Laroque, 1992). An insight provided by this model is that storage arbitrage may induce serial correlation in prices even if the fundamental shocks driving production and demand are uncorrelated. The model also implies that the distribution of commodity prices is skewed even under symmetric supply and demand shocks. Under the truth of the model, time series of prices will show isolated spikes, a feature determined by the possibility of occurrence of stockouts, i.e. periods in which discretionary stocks (that is, quantities held in addition to minimum operational stocks) fall to zero. Storage, in fact, introduces a key nonlinearity in the market demand, implying two different regimes of price volatility, one in which abundant reserves can buffer the effects of negative shocks in supply, and another in which, at high prices, the low levels of stocks leave the market particularly vulnerable to shocks in supply or demand.

The theoretical soundness of the standard storage model has long been recognized. After the pioneering work of Gustafson (1958), who showed how to solve for the stochastic dynamic equilibrium of the model, and thus anticipating the rational expectation hypothesis of Muth (1961), Scheinkman & Schechtman (1983) extended the model to include supply that is responsive to economic incentives and identified the analytical relationship of competitive market prices and stocks with those of a social surplus problem with possibly non-stationary fundamentals. Williams & Wright (1991) make a thorough exploration of the economic implications of the model and extend it in many important directions, including the implications of non-competitive behaviour and the effects of government interventions and speculative attacks. Bobenrieth H. et al. (2010) offer a rational explanation for episodes of high volatility in price series: in a storage model with continuously positive stocks, they prove the existence of rational price bubbles in expectation and show the possibility of occurrence of arbitrarily long periods with prices increasing at rates faster than the discount rate. They also prove that there exists a state-dependent finite horizon beyond which the price realization stays below any arbitrary fraction of the corresponding profile of conditional expectations. Their result raises delicate questions regarding the effects of speculation and of the standard interpretation of futures prices as conditional expectations.

The empirical validity of the standard storage model, however, has been repeatedly questioned and a clear consensus is yet to be reached, as highlighted recently by Deaton: "We have a long-established theory–whose insights are deep enough that *some* part of them *must* be correct–which is wildly at odds with the evidence, and where it is far from obvious what is wrong, or how the theory might be amended to give us a better handle on the mechanisms at work." (Deaton, forthcoming, emphasis in the original)

Empirical tests of the storage model began with Deaton & Laroque (1992) who introduced a Generalized Method of Moments (GMM) estimator and showed that the dynamics of the thirteen commodities they analysed are consistent with a two-regime autoregressive process in which current price is correlated to the previous one only when the latter is below a given threshold (a feature that *may* be due to storage). The results were encouraging, though they could not be deemed as definitive evidence in support of the storage model, given that other competing models of price behaviour could generate the two-regime auto-regression used to construct the GMM estimator (see Chapter 2). Deaton & Laroque supported their reservations, in spite of the GMM results, by simulations of versions of the model with different sets of parameter values which generate first order autocorrelations far lower than those observed on the annual time series of prices for thirteen commodities they consider. Given the limited range of parameter values they explored, however, they left open the question of whether there are other plausible values for the fundamental parameters of the model that could generate higher levels of serial correlation that would match those observed in the series of actual prices.

A few years later, introducing a path-breaking Pseudo Maximum Likelihood (PML) empirical estimation approach, Deaton & Laroque (1995, 1996) were able to estimate the parameters of the underlying demand and storage cost relations for the same thirteen series of annual average commodity prices they had considered previously, thus allowing for a formal test of a simplified version of the model, assuming linear demand, and storage cost due to proportional decay of the amount stored. They could not confirm the positive results of the GMM estimation, and found that, in order to account for observed levels of autocorrelation in their model, it was necessary to relax the assumption of i.i.d. harvest. When they did so, they were "forced to attribute effectively all [of the autocorrelation] to the underlying [harvest] process."(Deaton & Laroque, 1996, p.921) Their conclusion is summarized in Deaton & Laroque (2003, p.2): "[T]he speculative model, although capable of introducing some autocorrelation into an otherwise i.i.d. process, appears to be incapable of generating the high degree of serial correlation of most commodity prices."

The strong emphasis they put on the model rejection is surprising, considering that it would be too much to expect to be able to explain the evolution of prices of a diverse set of major commodities over almost a century with a model based on stationary linear consumption demand, a fixed distribution of market disturbances, a constant interest rate, and no supply response. Indeed, it would be very surprising if long-run market influences such as trends in the yields or changes in the structure of the supply and demand shocks had no detectable effect on the evolution of prices, let alone the presence of various forms of market intervention that have characterized the commodities analysed. The failure that Deaton & Laroque (1995, 1996) found is best interpreted as a rejection of the particular specification they adopted, not of the role of speculative storage in general. Also, it should be considered that practical implementation of the dynamic equilibrium model implied by the theory of storage arbitrage is *very* difficult. In Angus Deaton's own words, in this type of work "[I]t is difficult to disentangle the auxiliary assumptions from the central core that we want to test, the computations are time-consuming and error-prone, the substance of the problem tends to be lost in the sometimes byzantine complexity and programming of the estimation, and it is hard to get a sense of why the results are what they are." Deaton (2010, p.8)

Considering such difficulties, and being puzzled by the strong inconsistency between the results of the PML estimations and the previous GMM results on the very same price data series, Cafiero (2002) explored the possibility that the results in Deaton & Laroque (1995, 1996) might have been conditioned by some computational or programming problem. In fact, he was able to closely replicate the PML estimation of Deaton & Laroque (1995, 1996), and found that they were extremely sensitive to an implementation choice, namely the degree of accuracy in the numerical approximation of the equilibrium function. Even slight increases in the number of grid points used for function approximation led to dramatic changes of the estimated values. After improving on that particular aspect of the numerical implementation, and by exploring alternative assumptions on the nature of storage costs, Cafiero et al. (forthcoming) reach more positive conclusions regarding the empirical relevance of the standard storage model.

The results in Cafiero et al. (forthcoming) allow for the separation of two conceptually distinct issues. One is whether the standard storage model, even in a very simple version with linear demand, constant interest rate, and i.i.d. net supply shocks, is at all capable of reproducing the high levels of serial correlation observed in actual data series of commodity prices. The other one concerns the ability of estimated storage models to fit observed data from the point of view of a wider set of indicators. In Cafiero et al. (forthcoming) we tackle each of the issues in turn. First, we simulate the storage model for different values of the parameters and discuss the implied key characteristics of the price series. In contrast to the simulation presented by Deaton & Laroque (1992), we take a much steeper consumption demand, reflecting the fact that consumption of basic commodities is notably price inelastic. We find that, with the low price-response consumption demand, storage plays a greater role in determining price behaviour, causing a dramatic increase in the correlation measured on long series of simulated prices. Then, using the PML empirical estimation method and the same samples of commodity prices of Deaton & Laroque (1995, 1996), but improving on the accuracy of the numerical solution of the model, we find that the estimated model is indeed capable of replicating central features observed of real prices, including serial correlation, coefficient of variation, skewness and kurtosis for several of the commodities they considered.

In this chapter we elaborate further on the issues discussed in Cafiero et al. (forthcoming) by extending the analysis in two directions. First, as noted in Cafiero et al. (forthcoming), the assumptions of constant, positive marginal storage cost coupled with linear consumption demand can generate negative prices in this model. To avoid this problem, the model of Deaton & Laroque (1992) needs to be modified to allow for free disposal of the excess amount stored, and thus we need to introduce a more general version of the results of Theorem 1 and Theorem 3 of Deaton & Laroque (1992), and a proof of existence of a unique invariant distribution for prices. We also present a proof of the identification result (see the Proposition in Deaton & Laroque 1996) appropriate for our model.

Then, we apply the model to series of annual average prices of maize, wheat, rice and sugar, covering the period 1900-2010. We also fit the model to shorter series of the same prices, covering the period 1949-2010, and which we de-trend in consideration that our theoretical model is based on stationary prices.

Our results confirm in general the ability, already demonstrated by earlier findings, of the standard storage model to replicate the central features of the dynamics of prices for storable commodities. This means that the role that storage plays in determining price behaviour of the commodity prices should not be neglected. Further, we demonstrate how the models we estimate can be used to form predictions of future prices, and discuss the implication that such information should have for analyses of food security in general, and to inform policy-makers in particular with respect to the possibility of anticipating food price crises.

The remainder of the chapter is organized as follows. In the next section, we present the theoretical model and the main theoretical results on existence and uniqueness of the Stationary Rational Expectation Equilibrium for the model that allows for free disposal of the excess stocks, relegating to an appendix the formal proof of the various theorems and propositions introduced. In the following sections we describe, in turn, the estimation procedure and how we implement it, the data used, and the results obtained. A final section with discussion of the implications of our results for policy analysis and suggestions for further research closes the chapter.

A model with constant marginal storage cost and free disposal

We model a competitive commodity market in which, in any given period, available supply is comprised of a random component (the "harvest") plus the amount of stocks carried in from the previous period. Available supply is partly used for consumption and partly purchased by speculators motivated by expected profits. Speculators are assumed to form rational expectations of the next period price.

Supply shocks, ω_t, are i.i.d., with support in $\mathbb{R}$ that has lower bound $\underline{\omega} \in \mathbb{R}$. Storers are risk neutral and face a constant discount rate $r > 0$. Stocks physically deteriorate at rate d, with $0 \le d < 1$, and the cost of storing $x_t \ge 0$ units from time t to time $t+1$, paid at time t, is given by kx_t, with $k > 0$.

One possible state variable for this model is z_t, the total available supply at time t, defined as $z_t \equiv \omega_t + (1-d)x_{t-1}$, with $z_t \in Z \equiv [\underline{\omega}, \infty[$. Price is formed as $p_t = F(c_t)$, where consumption $c_t \equiv z_t - x_t$. The inverse consumer demand, $F : \mathbb{R} \to \mathbb{R}$, is continuous, strictly decreasing, and have the following properties: $\{c : F(c) = 0\} \ne \emptyset$, $\lim_{c \to -\infty} F(c) = \infty$, and $\left(\frac{1-d}{1+r}\right) EF(\omega_t) - k > 0$, where E denotes the expectation taken with respect to the random variable ω_t.

A stationary rational expectations equilibrium (SREE) in this model is a price function $p : Z \to \mathbb{R}$ which describes the current price p_t as a function of the state z_t, and which satisfies, for all z_t,

$$p_t = p(z_t) = \max\left\{\left(\frac{1-d}{1+r}\right) E_t p\Big(\omega_{t+1} + (1-d)x_t\Big) - k,\ F(z_t)\right\} \tag{1}$$

where:

$$x_t = \begin{cases} z_t - F^{-1}\big(p(z_t)\big), & \text{if} \quad z_t < z^* \equiv \inf\{z : p(z) = 0\} \\ z^* - F^{-1}(0), & \text{if} \quad z_t \ge z^*. \end{cases} \tag{2}$$

As the ω_t's are i.i.d., p is the solution to the following functional equation:

$$p(z) = \max\left\{\left(\frac{1-d}{1+r}\right) Ep\Big(\omega + (1-d)x(z)\Big) - k, F(z)\right\}, \tag{3}$$

and

$$x(z) = \begin{cases} z - F^{-1}\big(p(z)\big), & \text{if} \quad z < z^* \\ z^* - F^{-1}(0), & \text{if} \quad z \ge z^*. \end{cases} \tag{4}$$

Existence and uniqueness of the SREE, $p(z)$, as well as some of its properties are given by the following Theorem:

Theorem 1. *There is a unique stationary rational expectations equilibrium p in the class of continuous non-increasing functions. Furthermore, if* $p^* \equiv \left(\frac{1-d}{1+r}\right) Ep(\omega) - k$, *then:*

$$\begin{aligned} &p(z) = F(z), && \textit{for} \quad z \le F^{-1}(p^*), \\ &p(z) > \max\{F(z), 0\}, && \textit{for} \quad F^{-1}(p^*) < z < z^*, \\ &p(z) = 0, && \textit{for} \quad z \ge z^*. \end{aligned}$$

p is strictly decreasing whenever it is strictly positive. The equilibrium level of inventories, $x(z)$, is strictly increasing for z in $[F^{-1}(p^*), z^*]$.

The following comparative statics result parallels Theorem 3 of Deaton & Laroque (1992).

Theorem 2. *The equilibrium price function p, the associated cut-off price p^* and the inventory demand $x(z)$ are non-decreasing in the discount factor $\beta \equiv 1/(1+r)$. They are non-increasing in the marginal storage cost k, and they do not increase when there is a first-order stochastic increase in the distribution of supply shocks ω_t. Moreover, if $F(c)$ is convex, then $p(z)$ is convex, and both $p(z)$ and $x(z)$ do not decrease when the distribution of supply shocks is modified through a mean-preserving spread.*

We now establish existence and uniqueness of the invariant distribution for prices.

Theorem 3. *Let $\omega_t \in [\underline{\omega}, \overline{\omega}], -\infty < \underline{\omega} \leq \overline{\omega} < +\infty$. Suppose that ω_t has a mixed discrete-continuous distribution of the form $\alpha L_d + (1-\alpha)L_c$, where $0 \leq \alpha \leq 1$, L_d is a discrete distribution, and L_c is an absolutely continuous distribution with continuous and positive derivative m on $[\underline{\omega}, \overline{\omega}]$. Then the Markov process of available supply has a unique invariant distribution which is a global attractor, and has no atoms. Furthermore, the Markov process of prices has a unique invariant distribution, which is a global attractor.*

Remark. *Suppose that the inverse consumption demand $F : [0, +\infty) \to \mathbb{R} \cup \{+\infty\}$ is continuous, strictly decreasing, and satisfies $F(0) = +\infty$, $\{z : F(z) = 0\} \neq \emptyset$. If, under the assumptions of Theorem 3, $\underline{\omega} = 0$, $\omega_t = 0$ with positive probability, then:*

- *The invariant distribution of the price process has infinite expectation.*
- *Given any initial finite price p_0, the conditional expectation and the conditional variance of prices p_t diverge to $+\infty$, as $t \to +\infty$.*
- *Although the conditional expectation of prices increases with no bound, the probability that the sequence of realized prices stays below its own conditional expectation can be made arbitrarily close to one, by choosing a far enough finite time horizon.*

The following Proposition parallels Proposition 1 in Deaton & Laroque (1996, p. 906). This result allows identification of the model when only prices are observed, by arbitrarily setting the mean and the standard deviation of the supply shocks ω_t to be zero and one, respectively.

Proposition. *Consider a model with discount rate r, stocks deterioration parameter d, constant marginal and average storage cost k, supply shocks ω_t, and inverse demand function F. Any other model with discount rate r, stocks deterioration parameter d, constant marginal and average storage cost k, supply shocks $\widetilde{\omega}_t \equiv \sigma\omega_t + \mu$, and inverse demand function $\widetilde{F}$ satisfying $\widetilde{F}(\sigma z + \mu) = F(z)$, has the same rational expectations price process as the base model.*

The proof of all the Theorems, the Remark and the Proposition are presented in the Appendix.

Estimation

We estimate the model described above, assuming a linear inverse demand function, $F(c) = a + bc$, with $b < 0$, using the Pseudo Likelihood Maximization procedure introduced by Deaton & Laroque (1995, 1996). Such a procedure is based on the assumption that prices, conditional on the previous period price, $p_{t+1}|p_t$, are normally distributed, so that the log-pseudo likelihood function can be formed as follows:

$$\ln L = \sum_{t=1}^{T-1} \ln l_t = 0.5\left[-(T-1)\ln(2\pi) - \sum_{t=1}^{T-1} \ln s(p_t) - \sum_{t=1}^{T-1} \frac{\left(p_{t+1} - m(p_t)\right)^2}{s(p_t)}\right], \tag{5}$$

where $m(p_t)$ and $s(p_t)$ are the first and second central moments of the conditional price, respectively. Note that the distribution of prices in this model cannot be expected to be normal even if the underlying supply shocks are, because of the nonlinearity of the function that maps harvests to prices.

As described in Deaton & Laroque (1995), evaluation of the conditional expectation $m(p_t)$ and the conditional variance $s(p_t)$ is conducted in several steps, each of which in turn requires some practical assumptions, whose impact on the overall reliability of the implemented procedure and on the properties of the estimator is not obvious. The most delicate assumptions concern: 1) the choice of the approximation scheme for the SREE function p which, under the parameterizations maintained in this chapter, will have no closed form; and, 2) the way in which the expectations are calculated. Though various numerical approximation schemes are possible, including low order polynomials (Williams & Wright, 1991) or orthogonal collocation methods based on Chebychev polynomials (Miranda, 1985), we follow Deaton & Laroque (1995) and use cubic splines over a grid of equally spaced points. As in Cafiero (2002) and in Cafiero et al. (forthcoming), we use a large number of grid nodes to ensure sufficiently close approximation of the p function in the vicinity of the kink point corresponding to the threshold price p^*.

To take expectations with respect to the random shock ω, we substitute the integral over a continuous range of values of the harvest and corresponding density with a summation over a discrete set of 10 unequally spaced nodes ω^n and corresponding weights π^n.[2] Using this approximation, condition (1) can be expressed as:

$$p_t = p(z_t) = \max\left\{\left(\frac{1-d}{1+r}\right)\sum_{n=1}^{N} p\left(\omega^n + (1-d)x_t\right)\pi^n - k,\ a + bz_t\right\}. \tag{6}$$

Expression (6) defines a functional that can be solved iteratively for the function p. As noted above, we approximate p by a cubic spline over a grid of sufficiently many points to give a good approximation around the kink point and given a suitable range of values for z_t.[3]

Using the approximate SREE price function p, we calculate the first two moments of p_{t+1} conditional on p_t as:

$$m(p_t) = \begin{cases} \sum_{n=1}^{N} p\left(\omega^n + (1-d)\left(p^{-1}(p_t) - F^{-1}(p_t)\right)\right)\pi^n, & \text{if} \quad p_t > 0 \\ \sum_{n=1}^{N} p\left(\omega^n + (1-d)\left(z^* - F^{-1}(0)\right)\right)\pi^n, & \text{if} \quad p_t = 0, \end{cases}$$

[2] Deaton & Laroque (1995, section 3.1) chose a discretization with ten equally probable values. Our choice of nodes and weights is based on a Gauss-Hermite quadrature scheme optimally designed to approximate expectations of functions of standard normal random variables (see Judd, 1998, Section 7.2.).

[3] Our Matlab routines, available upon request, are based on the algorithm sketched in Deaton & Laroque (1995, Section 3.2), and suitably modified to reflect our extensions of the theoretical model, to include the restrictions represented by (2).

and

$$s(p_t) = \begin{cases} \sum_{n=1}^{N} p(\omega^n + (1-d)[p^{-1}(p_t) - F^{-1}(p_t)])^2 \pi^n - m^2(p_t), & \text{if} \quad p_t > 0 \\ \sum_{n=1}^{N} p(\omega^n + (1-d)[z^* - F^{-1}(0)])^2 \pi^n - m^2(p_t), & \text{if} \quad p_t = 0. \end{cases}$$

that we use to evaluate the expression in (5), which becomes a function of the parameters of the model, $\{a, b, k, d, r\}$.

Even though (5) is not the true log log-likelihood (in presence of storage prices will not be distributed normally), by the arguments in Gourieroux et al. (1984) the estimates are consistent.[4]

Data

Our data consists of annual prices for maize, wheat, rice and sugar extending over the period 1900-2010. The time series are presented in Pfaffenzeller et al. (2007) for the period up to 2003. We extend them from 2003 to 2010 using price data provided by the World Bank Development Prospects Group, following the procedure suggested therein to ensure homogeneity of the series. The monthly figures reported in the "World Bank Pink Sheets" are averaged over the calendar year, and then divided by the respective 1977-79 average. The normalized nominal values are then divided by the annual United States Consumer Price Index as reported by the US Bureau of Labor Statistics, to produce the real price indices depicted in Figure 15.1.

Results and discussion

We estimate the presented model using maize, wheat, rice and sugar price data. Although in principle the interest rate can be treated as a parameter, we do not attempt to estimate it, rather we set it at 2 percent, close to estimates of the real risk-free cost of capital in the United States and the United Kingdom in the twentieth century. (See for example Campbell, 1999; Goetzmann & Ibbotson, 2005; Shiller, 2005). Also, in all estimations the parameter d was never significantly different from zero, and therefore we set it at zero and estimate only the three parameters a, b and k in the results we present.

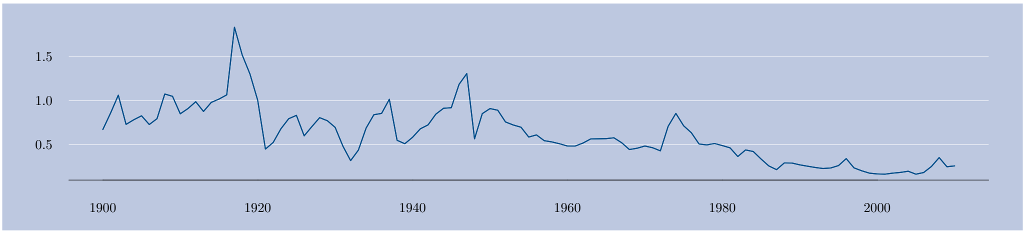
We start by using the series of deflated prices extending from 1900 to 2010, and are able to identify a well-behaved maximum of the Pseudo Likelihood function for Maize and Sugar.[5] The estimated parameters are reported in Table 15.1, along with the value of the maximized pseudo likelihood, the implied threshold price, p^*, and the resulting number of stockouts over the sample period. These estimates are largely in line with the results presented in Cafiero et al. (forthcoming, Table 7) and imply that there have been no stockouts for maize, and 22 stockouts for sugar over the period.

[4] Implementing a proper maximum likelihood estimator for this model, based on price observation but assuming a distribution for the harvests, poses significant challenges if stockouts are allowed. Forming the likelihood function would require the Jacobian of a non-differentiable function, implying discontinuities in the function to be maximized. Miranda & Rui (1999) present a maximum likelihood estimator based on the distribution of harvests, but in their model discontinuity of the objective function is eliminated by ruling out stockouts.

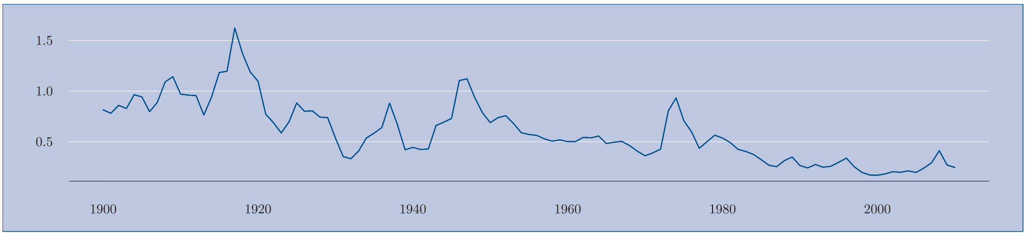
[5] For the other two series, the estimator did not converge, tending towards estimating an infinitely steep inverse demand function.

Figure 15.1: Annual real prices of maize, wheat, rice and sugar: 1900-2010

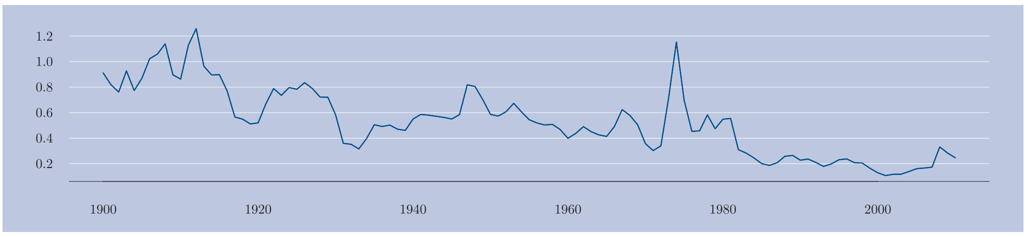
(a) Maize



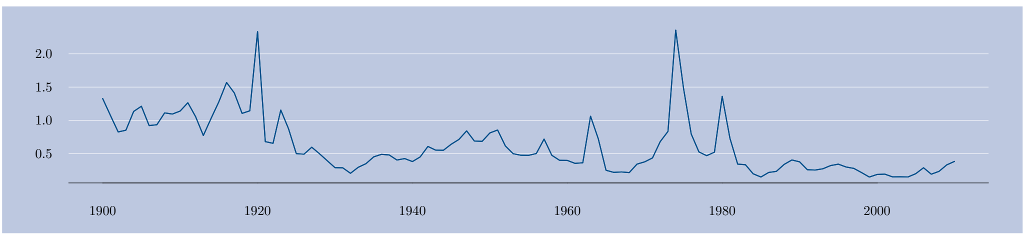
(b) Wheat



(c) Rice



(d) Sugar



Source: Pfaffenzeller et al. (2007) and The WorldBank Prospects Group.

One of the purposes of the estimations we present is to assess the ability of the storage model to capture key features of the distribution of prices. The model implies a long-run, invariant distribution of prices, whose moments could be compared with those observed in the data, as it is done for example in Deaton & Laroque (1996). This, however, would provide

Table 15.1: Parameter estimates on the series of deflated price data: 1949-2010

Commodity	Parameters⋆			PL	p^*	No. stockouts
	a	b	k			
Maize	0.7427	-3.3805	0.0054	82.5341	2.6090	0
	(0.185)	(0.691)	(0.0042)			
Sugar	0.4606	-1.0162	0.0192	24.5539	0.9272	22
	(0.1359)	(0.1788)	(0.0120)			

⋆ d is fixed at 0 and r is fixed at 0.02. Asymptotic standard errors in parentheses.

only a partial assessment of the actual fit of the model, given that observed series of prices are always too short to reveal higher-order moments of the underlying price distribution, especially if such a distribution is expected to be highly skewed. On the other hand, to be confident that a model is indeed capable of replicating such higher-order moments is crucial if the model is to be used to predict such features as price spikes, runs of low prices, etc.

To conduct a more coherent assessment of the models' fit, we follow the method presented in Cafiero et al. (forthcoming) and use the estimated parameters to simulate a long series of artificial prices[6] and then extract from it all possible subsamples of the same length as the observed data. On each subsample we measure the mean, the first and second order serial correlation, the coefficient of variation, the skewness and the kurtosis, in addition to calculating the number of stockouts. Finally, we identify in each of the simulated distribution of small sample price moments, the percentiles corresponding to the values of the corresponding moments as observed in the price data. Table 15.2 shows the values of the percentiles in the simulated distributions corresponding to the mean, the first and second order serial correlation, the coefficient of variation, the skewness and the kurtosis, observed on the price series for maize and sugar. With the exception of the mean for sugar, all observed price moments lie well within symmetric 90 percent confidence regions.

We can also consider the possible correlation between different features of the dynamics of prices to assess whether the model can generate series that have, for example, levels of *both* correlation and skewness similar to those observed in the data. The graph in Figure 15.2 illustrates the scatter plot of the values of coefficient of variation and of first order correlation measured on each simulated series, along with the marginal densities of the two variables, while the graph in Figure 15.3 does the same for first order serial correlation and skewness, both for the case of maize. The results of a similar exercise for sugar are reported in the graphs of Figure 15.4 and 15.5. The location of the combination of the corresponding two parameters measured on the series of data used to estimate the model is indicated by a white star in each of the graphs.

The graphs confirm that series of prices very much like those observed for maize and for sugar over a period of more than a century could well be generated by the standard storage model, even under an admittedly very simplified specification, using normally distributed i.i.d. supply shocks, linear demand and constant real interest rate. To some extent, this is a surprising result, considering that no one would defend the truth of the many maintained assumptions, such as, for example, the fact that agricultural commodity prices have been stationary over such a long period of time. Even a simple visual inspection of the series

6 In this chapter we simulate series of length 300 000.

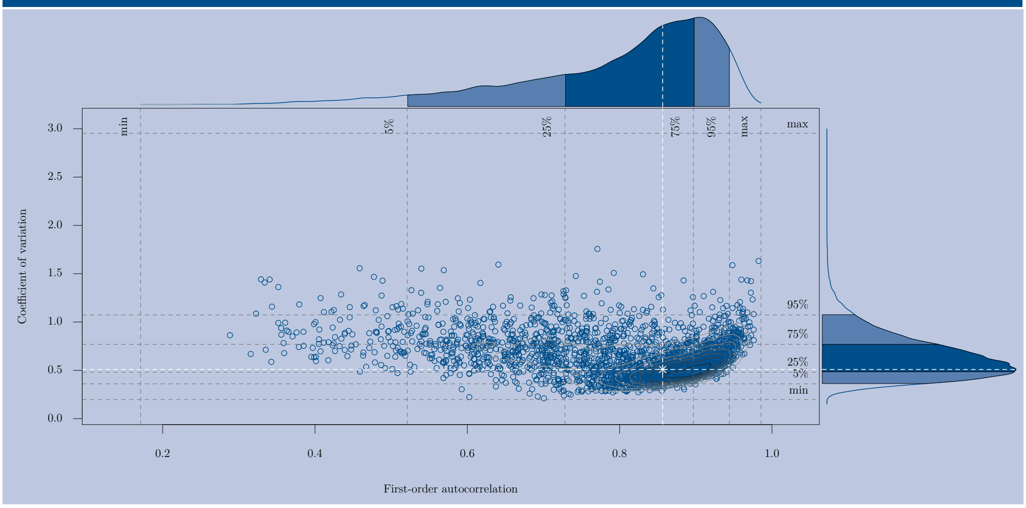
Table 15.2: Predicted features of price distributions: 1900-2010

Commodity	Moments*						% stockouts	Prob (s>0)
	μ	ρ_1	ρ_2	CV	Skewness	Kurtosis		
Maize	35.880	57.315	51.251	31.257	18.516	32.341	1.09	0.4381
Sugar	95.540	68.514	57.472	60.417	24.300	21.961	5.19	0.9399

* Each number is the percentile of the distribution corresponding to the observed value of each given moment. μ is the mean, ρ_1 is the first order serial correlation, ρ_2 is the second order serial correlation, CV is the coefficient of variation.

Note: For each commodity, we generated a series of 300 000 prices using the estimated parameters reported in Table 15.1. We then extracted all possible subsamples of the same length of the data series, and measured mean, first order and second order autocorrelation, coefficient of variation, skewness and kurtosis on each simulated sample. The numbers in the table are the percentiles of these simulated distributions corresponding to the values observed in the data. Prob(s>0) is the relative frequency of samples with at least one stockouts in the simulated series.

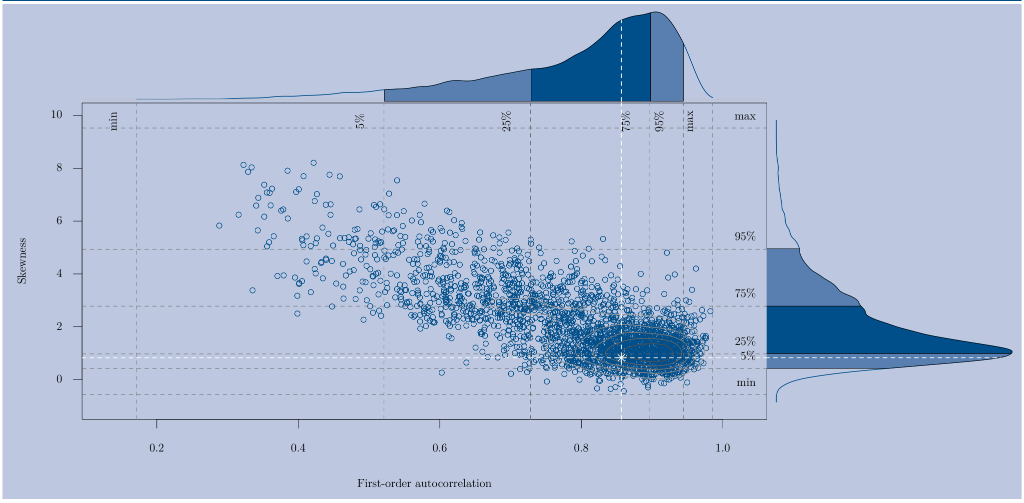
Figure 15.2: Empirical joint distribution of first-order correlation & coefficient of variation as predicted by the storage model in samples of length 111, and estimated on maize deflated prices: 1900-2010



Note: The shaded areas in the densities and the corresponding grid lines in the plots indicate the minimum, the 5th, 25th, 75th and 95th percentiles and the maximum value obtained in the simulation. A white star indicates the position of the the first order serial correlation and coefficient of variation measured on the series of maize prices.

plotted in Figure 15.1 reveals that all price series show an obvious downward trend, and, possibly, a structural change after World War II. Indeed, the presence of such a trend poses a challenge to a model that assumes that the fundamentals are stationary. In fact, this may well be the reason that the storage model, as specified, cannot be fitted to the other two series of prices we considered.

Figure 15.3: Empirical joint distribution of first-order correlation & skewness as predicted by the storage model in samples of length 111, and estimated on maize deflated prices: 1900-2010



Note: The shaded areas in the densities and the corresponding grid lines in the plots indicate the minimum, the 5th, 25th, 75th and 95th percentiles and the maximum value obtained in the simulation. A white star indicates the position of the the first order serial correlation and skewness measured on the series of maize prices.

Table 15.3: Parameter estimates on the series of de-trended data: 1949-2010

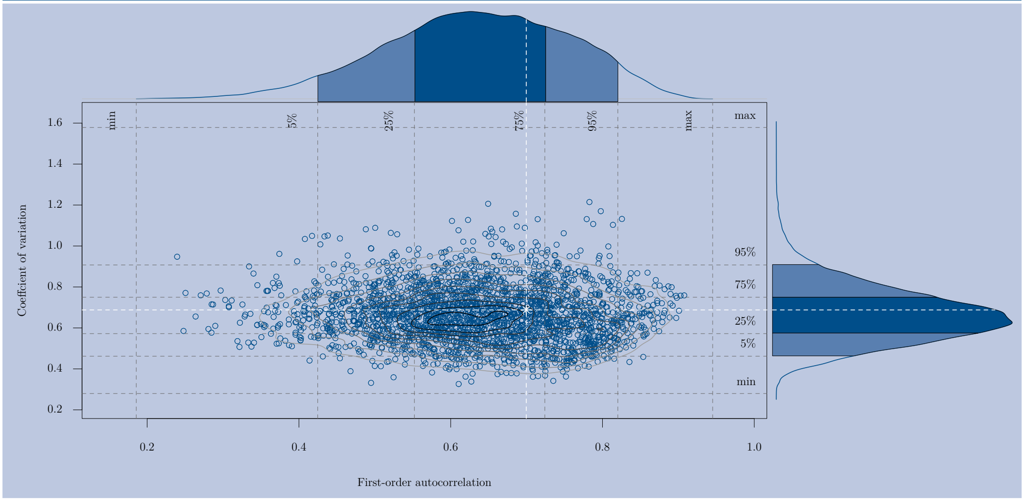
Commodity	Parameters⋆			PL †	p^*	No. stockouts
	a	b	k			
Maize	1.1280	-0.6819	0.0398	19.9838	1.3344	6
	(0.075)	(0.074)	(0.015)			
Wheat	1.0331	-0.7465	0.0232	19.4156	1.3146	8
	(0.002)	(0.001)	(0.0003)			
Rice	1.0359	-1.0046	0.0409	-1.7488	1.4082	9
	(0.004)	(0.002)	(0.0006)			
Sugar	1.1104	-2.2488	0.0654	-36.0000	2.0720	3
	(0.493)	(0.447)	(0.063)			

⋆ d is fixed at 0 and r is fixed at 0.02. Asymptotic standard errors in parentheses. † PL is the value of the maximized Pseudo Likelihood.

In light of this, in the next set of estimations we consider the de-trended series covering the period 1949-2010, obtained by subtracting from the original series a log-linear trend component estimated by ordinary Least Squares. The resulting de-trended series of real prices are depicted in Figure 15.6.

Not surprisingly, we are able to fit the storage model to all of the de-trended series. Table 15.3 reports the results of the estimations, and Table 15.4 the assessment of the ability of the estimated models to reproduce the moments of the price data.

Figure 15.4: Empirical joint distribution of first order correlation and coefficient of variation as predicted by the storage model in samples of length 111, and estimated on sugar deflated prices: 1900-2010



Note: The shaded areas in the densities and the corresponding grid lines in the plots indicate the minimum, the 5th, 25th, 75th and 95th percentiles and the maximum value obtained in the simulation. A white star indicates the position of the the first order serial correlation and coefficient of variation measured on the series of sugar prices.

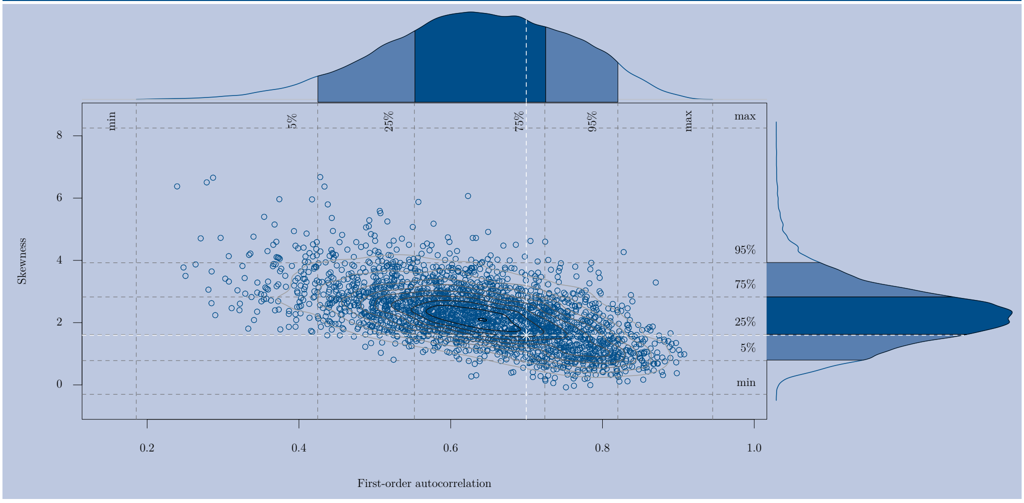
Table 15.4: Predicted features of price distributions. De-trended data: 1949-2010

Commodity	Moments⋆					
	μ	ρ_1	ρ_2	CV	Skewness	Kurtosis
Maize	15.898	99.036	90.399	43.562	25.646	23.257
Wheat	49.768	92.610	60.542	49.582	47.970	43.477
Rice	58.194	87.344	42.991	58.445	70.165	70.333
Sugar	57.898	50.023	17.705	68.264	91.855	89.533

⋆ Each number is the percentile of the distribution corresponding to the observed value of each given moment. μ is the mean, ρ_1 is the first order serial correlation, ρ_2 is the second order serial correlation, CV is the coefficient of variation.
Note: For each commodity, we generated a series of 300 000 prices using the estimated parameters reported in table 15.1. We then extracted all possible subsamples of the same length of the data series, and measured mean, first order and second order autocorrelation, coefficient of variation, skewness and kurtosis on each simulated sample. The numbers in the table are the percentiles of these simulated distributions corresponding to the values observed in the data.

With the exception of first order serial correlation for maize, all of the moments of the data series are within the central 90 percent confidence regions, demonstrating that the ability to fit many characteristics of the distribution of commodity prices must be recognized as a general feature of the standard storage model, despite the many simplifying assumptions, some of which –such as our choice of assuming a log-linear form of the trend– are admittedly

Figure 15.5: Empirical joint distribution of first-order correlation & skewness as predicted by the storage model in samples of length 111, and estimated on sugar deflated prices: 1900-2010



Note: The shaded areas in the densities and the corresponding grid lines in the plots indicate the minimum, the 5th, 25th, 75th and 95th percentiles and the maximum value obtained in the simulation. A white star indicates the position of the the first order serial correlation and skewness measured on the series of sugar prices.

ad hoc, and others –such as the assumption of a constant real interest rate over long periods, or the absence of policy distortions– are clearly at odds with what we know of the markets of these commodities over the past sixty years. We do not pursue this particular issue further in this chapter, postponing the exploration of how to relax the assumptions to future very promising research. What suffices here, is to have demonstrated once again that the standard storage model is empirically validated by a broad set of agricultural commodity price series, including those of two of the World's major food staples such as wheat and rice.

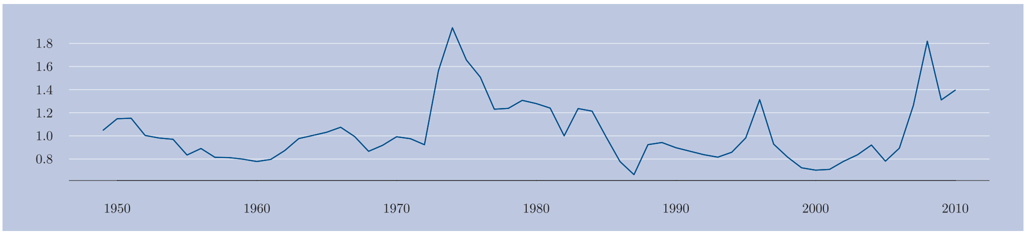
Our next objective is to demonstrate the potential usefulness of the model for policy analysis, and we base the discussion on one of the features of commodity price dynamics that has attracted much policy attention recently.

One important focus of the ongoing debate on commodity price volatility is the occurrence of price spikes and how they relate to the evolution of market fundamentals (production, trade, consumption and stock changes). The inability to closely match price spikes with current production shortfalls, for example, has led many to invoke irrational market behaviour, and to claim that uncontrolled speculation must be at the origin of what should be deemed to be commodity price bubbles. In the storage model, price spikes are predictable events, associated with periods in which discretionary stocks are at minimum levels. Indeed, in all price series we consider, the estimates imply spikes, rationalized here as periods of effective stockouts. For all commodities, the estimated models identifies a small number of such occurrence, as reported in last column of Table 15.3, corresponding to the peaks in the graphs of Figure 15.6.

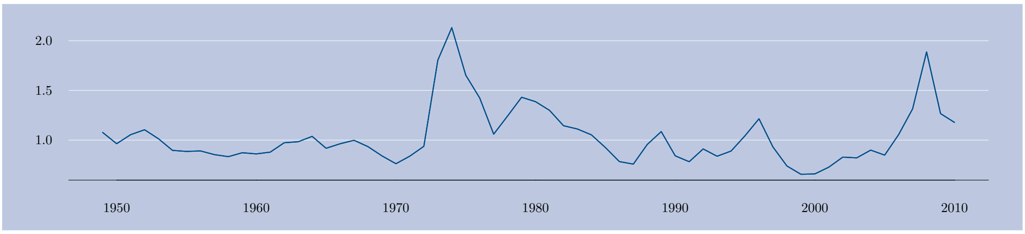
To explore the implications of the estimated models in terms of predicted number of stockouts we measure the frequency of stockouts in the long-run distribution of prices,

Figure 15.6: Annual de-trended real price indexes of maize, wheat, rice and sugar: 1949-2010

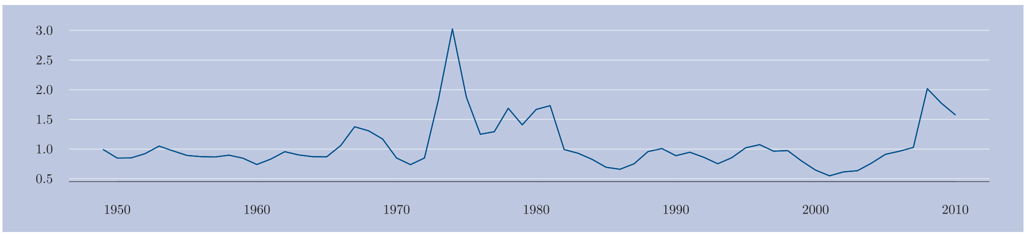
(a) Maize



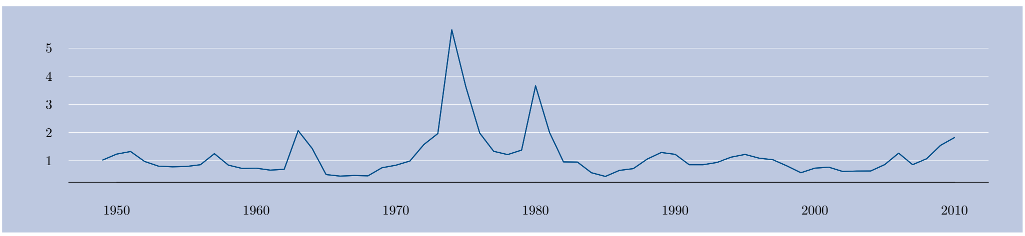
(b) Wheat



(c) Rice



(d) Sugar



Source: Pfaffenzeller et al. (2007) and WorldBank Prospect Groups.

and the relative frequency of samples with at least one, more than five, and more than ten stockouts, in the large number of simulated samples of length 62. Table 15.5 shows the results for the four different commodities.

Table 15.5: Predicted incidence of stockouts

Commodity	% stockouts	Prob($s > 0$)	Prob($s > 5$)	Prob($s > 10$)
Maize	14.89	0.9965	0.8019	0.3567
Wheat	10.06	0.9678	0.5327	0.1331
Rice	10.56	0.9746	0.5636	0.1523
Sugar	7.06	0.9020	0.3197	0.0511

Note: % stockouts is the percent of prices, over a long series of 300 000, exceeding the estimated threshold value p^* as reported in Table 15.3. s indicates the number of stockouts in a series of 62 prices. The probability of s exceeding n is estimated as the ratio between the number of samples containing more than n stockouts and the total number of simulated samples.

As we can see, the estimated models imply that price spikes in the markets for these commodities are not so rare. Over a very long span of time, about 15 percent of the periods for maize, 10 percent for wheat and rice and 7 percent for sugar would correspond to a stockout. That at least one stockout would occur in a period of 62 years is very likely, with probability ranging from 0.9 for sugar to over 0.99 for maize. Even periods with ten stockouts or more are not so rare, based on the estimated probability presented in the last column of Table 15.5.

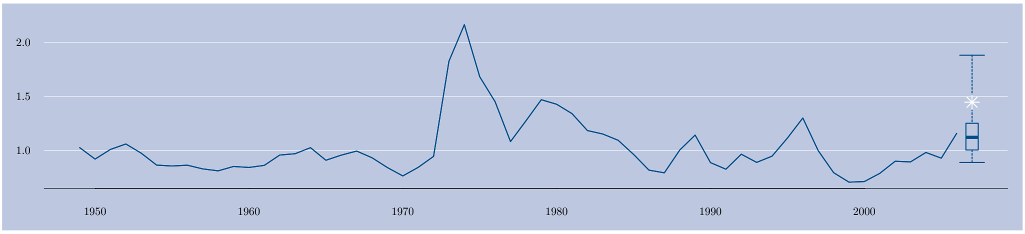
One of the advantages of a structural model like the one we estimate is that it can be used to identify the likelihood of price spikes given the current conditions. As an example, for wheat we tested the practical ability of the estimated model to predict the price spikes that occurred in the 2007-2008 food crisis. For the prediction experiment to be consistent with information available in each time period, we estimated the model to predict the prices for 2007 and 2008 considering only the sub-samples 1949-2006 and 1949-2007 respectively. The highly non-linear character of price variations, as reflected in its marked conditional skewness, implies that not only the point predictor for price in the future is conditional on the state of the system in each period, but, importantly, so is the shape of its conditional distribution.

The box plot on the right end of the graph in Figure 15.7 shows the conditional density for the price of wheat for 2007 as it would have been predicted in 2006, while Figure 15.8 shows the prediction for 2008, conditional on the information available in 2007. Far from being a complete surprise, prices as high as that of 2007 and 2008 should have been considered within the realm of possibility. The actual price of 2007 (indicated by a white star in the graphs of Figure 15.7 lays at the 85.5 percentile of the distribution of one period ahead predicted prices in 2006, and that of 2008 (the white star in the graph of Figure 15.8) at the 91.2 percentile of the predictions formed in 2007.

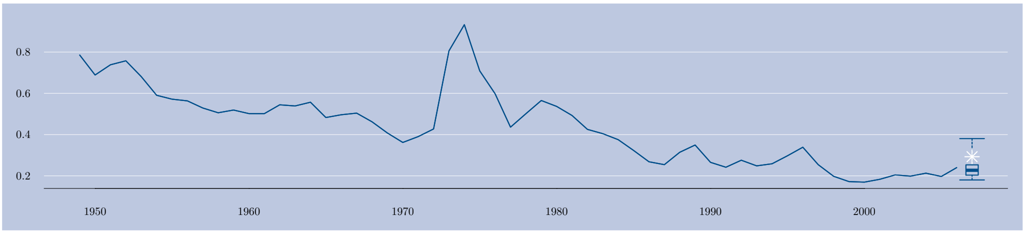
We do not claim that these would have been the best possible predictions to be formed before the actual price spike occurred. The model we present here is based on a highly simplifying assumption and only uses information on the past history of prices. Possible model refinements ought to also take into account available reliable information on the amount of stocks, if any, on production and consumption forecasts, so that the distribution of the expected net supply shock could be better calibrated. Also, more complete models should explore alternative specifications for the underlying demand function and supply response. These are all avenues to be explored in an exciting renewed research programme that, unfortunately, has been relatively idle in the past fifteen years.

Figure 15.7: One-step ahead prediction of wheat price (as of year 2006)

(a) De-trended series



(b) Original series



Note: The first panel shows de-trended prices. The second plot shows the original data and the conditional distribution of one period ahead price prediction, inclusive of trend.

Conclusions

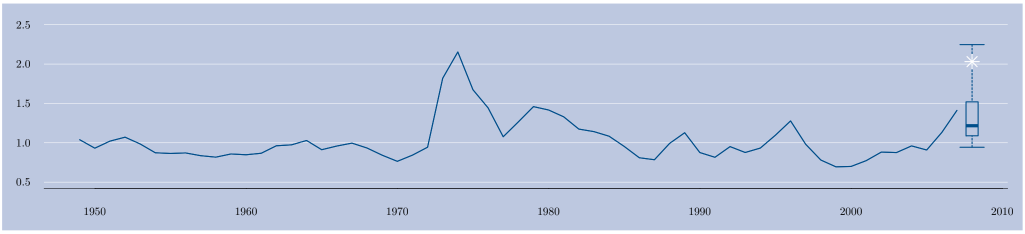
This chapter has presented the results of application of the PML estimator of the standard storage model to series of real prices of major agricultural commodities. The results have confirmed the empirical relevance of the model. Storage arbitrage has been shown as being highly consistent with many features of the dynamics of commodity prices, including correlation and skewness. Contrary to previous findings, the evidence contained in the series of annual real price indexes does not reject even a version of the model that has been highly simplified to make it amenable to easier numerical implementation.

We have demonstrated how the model can be used to predict future prices, conditional on current information. The distributions of predicted future prices are highly skewed even when based on the assumptions of symmetric net supply shocks and linear demand, thus highlighting the possibility of price spiking above current levels.

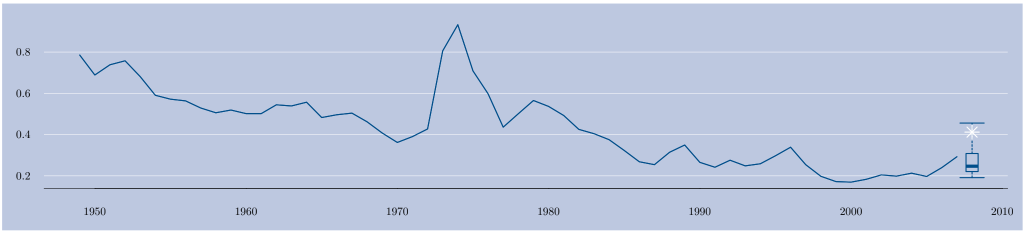
Many areas exist for improving the estimator. Inclusion of supply response, modelling a time varying real interest rate, or exploring alternative specifications for the demand schedule - just to name a few - are all avenues to be explored in search of higher efficiency in predicting future prices. One thing is clear: a consistent treatment of the implication of intertemporal arbitrage through storage should be a fundamental ingredient of any serious analysis of commodity price behaviour.

Figure 15.8: One-step ahead prediction of wheat price (as of year 2007)

(a) De-trended series



(b) Original series



Note: The first panel shows de-trended prices. The second plot shows the original data and the conditional distribution of one period ahead price prediction, inclusive of trend.

Proof of Theorem 1

Our proof follows the structure of the proof of Theorem 1 in Deaton & Laroque (1992).

We first prove several preliminary results.

Consider $Y \equiv \{(q,z) : z \in Z, q \geq \max\{F(z), 0\}\}$. Let $g : Z \to [0, \infty[$ be a continuous, non-increasing function, such that $g(z) \geq F(z) \forall z \in Z$. Define $G : Y \to \mathbb{R}$ by:

$$G(q,z) \equiv \left(\frac{1-d}{1+r}\right) Eg(\omega + (1-d)x(q,z)) - k,$$

where

$$x(q,z) \equiv \begin{cases} z - F^{-1}(q), & \text{if} \quad z < z_g^* \\ z_g^* - F^{-1}(q), & \text{if} \quad z \geq z_g^* \end{cases}$$

and

$$z_g^* \equiv \inf\left\{ z \geq F^{-1}(0) : \left(\frac{1-d}{1+r}\right) Eg\Big(\omega + (1-d)(z - F^{-1}(0))\Big) - k = 0 \right\}.$$

We denote by T the operator that assigns to the function g the function Tg which satisfies the following functional equation:

$$Tg(z) = \max\{G(Tg(z), z), F(z)\}. \tag{7}$$

A SREE is a function g such that $Tg = g$.

Lemma 1. *Assume that* $g: Z \to [0,\infty[$ *is a continuous, non-increasing function, such that* $g(z) \geq F(z), \forall z \in Z$. *Then* $G: Y \to \mathbb{R}$ *is continuous and non-increasing in both its arguments. Furthermore, if* $z < z_g^*$,

$$G(F(z),z) = \left(\frac{1-d}{1+r}\right) Eg(\omega) - k.$$

Proof. [Proof of Lemma 1] Trivial. Note that x is continuous and g is uniformly continuous. □

Lemma 2. *Assume that* g *satisfies the hypotheses of Lemma 1. Then:*

1. *There exists a unique function* Tg *which is the solution of* (7). $Tg: Z \to [0,\infty[$ *is continuous, non-increasing and:*

$$\begin{aligned} Tg(z) &= F(z), && \text{for } F(z) \geq \left(\tfrac{1-d}{1+r}\right) Eg(\omega) - k \\ Tg(z) &= G(Tg(z),z), && \text{for } F(z) < \left(\tfrac{1-d}{1+r}\right) Eg(\omega) - k \end{aligned}$$

2. *Furthermore,* $g_1 \geq g_2 \Rightarrow Tg_1 \geq Tg_2$.

Proof. [Proof of Lemma 2]

1. For a given $z \in Z$, $Tg(z)$ is equal to the solution in unknown q, $q \geq \max\{F(z),0\}$, of:

$$\psi_z(q) \equiv \max\{G(q,z) - q, F(z) - q\} = 0.$$

   $\psi_z(q)$ is strictly decreasing and continuous in q, and

$$\psi_z\Big(\big[\max\{F(z),0\},\infty\big[\Big) = \Big]-\infty, \psi_z\big(\max\{F(z),0\}\big)\Big].$$

   To evaluate $\psi_z\big(\max\{F(z),0\}\big)$ we consider three cases:

   (a) **Case 1:** For $\underline{\omega} \leq z \leq F^{-1}(0)$,

$$\psi_z\big(\max\{F(z),0\}\big) = \psi_z\big(F(z)\big) = \max\left\{\left(\frac{1-d}{1+r}\right) Eg(\omega) - k - F(z), 0\right\}.$$

   If $F(z) \geq \left(\frac{1-d}{1+r}\right) Eg(\omega) - k$, then $\psi_z\big(F(z)\big) = 0$, and $Tg(z) = F(z)$.
   If $F(z) < \left(\frac{1-d}{1+r}\right) Eg(\omega) - k$, then $\psi_z\big(F(z)\big) > 0$, $Tg(z)$ exists and satisfies $Tg(z) = G\big(Tg(z),z\big)$.

   (b) **Case 2:** For $F^{-1}(0) < z < z_g^*$,

$$\psi_z\big(\max\{F(z),0\}\big) = \psi_z(0) = \max\{G(0,z),F(z)\} = G(0,z) > 0.$$

   Then $Tg(z)$ exists and satisfies $Tg(z) = G\big(Tg(z),z\big)$.

   (c) **Case 3:** For $z \geq z_g^*$,

$$\begin{aligned} \psi_z\big(\max\{F(z),0\}\big) &= \psi_z(0) = \max\{G(0,z),F(z)\} = G(0,z) \\ &= \left(\frac{1-d}{1+r}\right) Eg\Big(\omega + (1-d)(z_g^* - F^{-1}(0))\Big) - k = 0. \end{aligned}$$

   Therefore $Tg(z) = 0$ and satisfies $Tg(z) = G\big(Tg(z),z\big)$.

   This proves the existence and uniqueness of the solution $Tg(z)$. Continuity and monotonicity follow from the continuity and monotonicity of $\max\{G(q,z) - q, F(z) - q\}$.

2. Let g_1, g_2 be two functions that satisfy the hypotheses of Lemma 1, and such that $g_1 \geq g_2$. Then, $z_{g_1}^* \geq z_{g_2}^*$.

(a) **Case 1:** For $z < z^*_{g_2}, G_1(q,z) \geq G_2(q,z) \quad \forall q \geq \max\{F(z),0\}$, and therefore $Tg_1(z) \geq Tg_2(z)$.

(b) **Case 2:** For $z \geq z^*_{g_2}, Tg_2(z) = 0$, and therefore $Tg_1(z) \geq Tg_2(z)$.

□

Lemma 3. *1. If p is a SREE, and p is non-increasing in z, then $p(\underline{\omega}) = F(\underline{\omega})$.*

2. If g satisfies the assumptions of Lemma 1 and $g(\underline{\omega}) = F(\underline{\omega})$, then $Tg(\underline{\omega}) = F(\underline{\omega})$.

Proof. [Proof of Lemma 3.] Deaton & Laroque (1992, p.21). □

Proof. [Proof of Theorem 1] We can now prove theorem 1, which is composed of three parts.

1. Consider two functions g_1, g_2 satisfying the hypotheses of Lemma 1, and such that there exists a non-negative constant a with $g_2 \leq g_1 + a$.
By Lemma 2 (2.),

$$Tg_2 \leq T(g_1 + a).$$

For $z < z^*_{g_1}$,

$$\begin{aligned} T(g_1+a)(z) &\leq \max\left\{\left(\frac{1-d}{1+r}\right)Eg_1\Big(\omega+(1-d)\big(z-F^{-1}(Tg_1(z))\big)\Big)-k, F(z)\right\}+\left(\frac{1-d}{1+r}\right)a \\ &= Tg_1(z)+\left(\frac{1-d}{1+r}\right)a. \end{aligned}$$

For $z^*_{g_1} \leq z < z^*_{g_1+a}$,

$$\begin{aligned} T(g_1+a)(z) &\leq \max\left\{\left(\frac{1-d}{1+r}\right)Eg_1\Big(\omega+(1-d)\big(z^*_{g_1}-F^{-1}(0)\big)\Big)-k, F(z)\right\} + \left(\frac{1-d}{1+r}\right)a \\ &= Tg_1(z)+\left(\frac{1-d}{1+r}\right)a. \end{aligned}$$

For $z \geq z^*_{g_1+a}$,

$$T(g_1+a)(z) = 0 \leq Tg_1(z)+\left(\frac{1-d}{1+r}\right)a.$$

Therefore, $T(g_1+a) \leq Tg_1 + \left(\frac{1-d}{1+r}\right)a$. We conclude that :

$$Tg_2 \leq Tg_1 + \left(\frac{1-d}{1+r}\right)a. \tag{8}$$

Let $\mathcal{G} \equiv \{g : Z \to [0,\infty[; g$ is continuous, non-increasing, $g \geq F$, $g(\underline{\omega}) = F(\underline{\omega})\}$.
Lemma 2 and Lemma 3 imply that $T(\mathcal{G}) \subseteq \mathcal{G}$.

$$d(g_1,g_2) \equiv \sup_{z\in Z}|g_1(z)-g_2(z)|, \quad g_1,g_2 \in \mathcal{G}$$

is a metric on $\mathcal{G}$.
For any $g_1, g_2 \in \mathcal{G}$, taking $a = d(g_1,g_2)$ in (8) we conclude that:

$$d(Tg_1,Tg_2) \leq \left(\frac{1-d}{1+r}\right)d(g_1,g_2)$$

Thus the operator T is a contraction in the complete metric space $(\mathcal{G},d)$, and therefore it has a unique fixed point $p \in \mathcal{G}$.

2. p is strictly decreasing whenever it is strictly positive:
   If not, as p is non-increasing, there is an interval where p is a positive constant. We have two cases:

   (a) **Case 1:** Suppose there exists a first interval $I \equiv [z', z'']$ where p is constant. Let $B \equiv p(z')$. $\forall\, z \in I$,

   $$B = p(z) = \left(\frac{1-d}{1+r}\right) Ep\Big(\omega + (1-d)\big(z - F^{-1}(B)\big)\Big) - k$$

   As p is non-increasing, $p\Big(\underline{\omega} + (1-d)\big(z - F^{-1}(B)\big)\Big)$ is constant $(\leq B)$, for $z \in I$. Therefore,

   $$B \leq \left(\frac{1-d}{1+r}\right) B - k, \qquad \text{a contradiction.}$$

   (b) **Case 2:** Suppose there is no first interval where p is constant. Let

   $$\mathcal{I} \equiv \{I \;:\; I \text{ is an interval where } p \text{ is constant}\}$$

   and let $\overline{p} \equiv \sup\{p(z) : z \in I \text{ and } I \in \mathcal{I}\}$.
   As there is no first interval where p is constant, $\overline{p}$ is accumulated by a sequence of values of p in I, $I \in \mathcal{I}$.
   Take any $\epsilon > 0$ and consider an interval I such that the value of p in I is $\geq \overline{p} - \epsilon$. Let $B \equiv$ value of p in I. $\forall z \in I$,

   $$B = p(z) = \left(\frac{1-d}{1+r}\right) Ep\Big(\omega + (1-d)\big(z - F^{-1}(B)\big)\Big) - k.$$

   As p is non-increasing, $p\Big(\underline{\omega} + (1-d)\big(z - F^{-1}(B)\big)\Big)$ is constant for $z \in I$ and

   $$p\Big(\underline{\omega} + (1-d)\big(z - F^{-1}(B)\big)\Big) \leq \overline{p}.$$

   Therefore,

   $$B \leq \left(\frac{1-d}{1+r}\right) \overline{p} - k,$$

   and then,

   $$B \leq \left(\frac{1-d}{1+r}\right) (B + \epsilon) - k.$$

   As $\epsilon > 0$ is arbitrary, we obtain a contradiction.

3. The equilibrium level of inventories, $x(z)$, is strictly increasing for z in $\left[F^{-1}(p^*), z^*\right]$:
   Let $z_1 < z_2$ in $\left[F^{-1}(p^*), z^*\right]$. As p is strictly decreasing in this interval, $p(z_1) > p(z_2)$. Therefore,

   $$\left(\frac{1-d}{1+r}\right) Ep(\omega + (1-d)x(z_1)) - k > \left(\frac{1-d}{1+r}\right) Ep(\omega + (1-d)x(z_2)) - k,$$

   which implies that $x(z_1) < x(z_2)$.

□

Proof of Theorem 2

The proof follows the same structure of the proof of Theorem 3 in Deaton & Laroque (1992).

Proof. The first two statements of Theorem 2 are trivial by definition. For the last part consider:

- **Claim 1:** If F is convex, then the equilibrium price function p is convex. To prove Claim 1, it suffices to prove that Tg is convex, whenever g is convex. Assume then that $g: Z \to [0,\infty[$ is a convex, continuous, non-increasing function, such that $g(z) \geq F(z)$, $\forall\, z \in Z$. Then given that F is convex and decreasing, we conclude that the associated function $G = G(q,z)$ is a convex function in the pair (q,z). Remember from the proof of Lemma 2 that for any given $z \in Z$, $Tg(z)$ is equal to the solution in unknown q, $q \geq \max\{F(z),0\}$, of:

$$\psi_z(q) \equiv \max\{G(q,z) - q, F(z) - q\} = 0.$$

As $\psi_z(q)$ is the maximum of two convex functions, it is convex in the pair (q,z). If $,z',z'' \in Z$, and $\theta \in [0,1]$, then:

$$\psi_{z'}(q') = \psi_{z''}(q'') \;=\; 0, \quad \text{where} \quad q' = Tg(z'), \quad \text{and} \quad q'' = Tg(z'').$$

Therefore, by the convexity of $\psi_z(q)$ in (q,z), we conclude:

$$\psi_{\theta z' + (1-\theta) z''}(\theta q' + (1-\theta) q'') \;\leq\; \theta \psi_{z'}(q') \;+\; (1-\theta)\psi_{z''}(q'') = 0,$$

and given that $\psi_z(q)$ is decreasing in q, we conclude the convexity of Tg.

- **Claim 2:** If F is convex, then $p(z)$ and $x(z)$ increase when the distribution of supply shocks is modified through a mean-preserving spread.
To prove Claim 2 for a convex, continuous and non-increasing function g, let $G_1(q,z), z^*_{g,1}$ be the G function and the z^*_g point that we mention in the proof of Theorem 1 for an initial distribution of supply shocks, and let $G_2(q,z), z^*_{g,2}$ be the corresponding elements for supply shocks with distribution modified through a mean preserving spread. By the convexity of g we have that $z^*_{g,1} \leq z^*_{g,2}$. If $z < z^*_{g,1}$, then $G_1(q,z) \leq G_2(q,z)$, $\forall\; q \geq \max\{F(z),0\}$, and therefore $T_1 g(z) \leq T_2 g(z)$, where T_1, T_2 denote the corresponding contractions. If $z \geq z^*_{g,1}$, then $T_1 g(z) = 0$, and hence $T_1 g(z) \leq T_2 g(z)$, concluding

$$T_2 g(z) \;\geq\; T_1 g(z), \quad \forall\, z \in Z,$$

From this last result, and from the fact that $T_1 g$ is convex and Lemma 2 (2.), we obtain that the corresponding equilibrium price functions p_1 and p_2 satisfy:

$$p_2(z) \;\geq\; p_1(z), \quad \forall\, z \in Z.$$

□

Proof of Theorem 3

Proof. Note that $x(z)$ is continuous, non-decreasing, and bounded by $\overline{x} \equiv z^* - F^{-1}(0)$. A suitable state space for available supply is $S \equiv [\underline{\omega}, \overline{z}]$, where $\overline{z} \equiv \overline{x} + \overline{\omega} < +\infty$.

The transition probability for the available supply process is given by:

$$P[z_{t+1} \leq a' \mid z_t = a] \;=$$
$$begincases 0, \text{ if } \quad a' < (1-d)x(a) + \underline{\omega}$$
$$\sum \alpha_i \;+\; (1-\alpha) \int_{\underline{\omega}}^{a' - (1-d)x(a)} m(\omega) d(\omega), \text{ if } \quad a' \geq (1-d)x(a) + \underline{\omega}$$

where $\sum \alpha_i$ denotes the sum of weights of atoms in the shocks that are less than or equal to $a' - (1-d)x(a)$. The Markov operator associated to this transition probability can be written as:

$$T = \alpha T_1 \ + \ (1-\alpha) T_2,$$

where T_1 is a linear and continuous operator which takes the discrete part, and:

$$T_2 u(a) = \int_S u(z')\, m(z' - (1-d)x(a)) dz',$$

for each bounded and measurable function $u : S \to \mathbb{R}$.

In the case $\alpha < 1$, from Theorem 4.6 in Futia (1982, p. 394), T_2 is weakly compact, implying that T_2^2 is compact, and then T_2 is quasicompact. Noting that T_1 is linear and continuous, Theorem 4.10 in Futia (1982, p. 397) implies that T is quasicompact. As u continuous $\Rightarrow$ Tu continuous, by Theorem 3.3 in Futia (1982, p. 389) we conclude that T is equicontinuous. In the discrete case $\alpha = 1$, using the same results in Futia (1982, Theorem 4.6 and Theorem 3.3) we obtain that T is equicontinuous. Observing that the transition probability P satisfies the Uniqueness Criterion 2.11 in Futia with respect to the point $\underline{\omega}$, by Theorem 2.12 in Futia (1982, p. 385), we conclude that there is a unique invariant probability measure γ_* for the available supply process.

Finally, noting that the transition probability P satisfies, with respect to the point $\underline{\omega}$, what is called in Futia a Generalized Uniqueness Criterion, Theorems 3.2, 3.6, and 3.7 in Futia (1982, pp. 394 and 390) imply that, given any initial distribution γ_0 for the initial available supply, the corresponding sequence of distributions of the available supplies for the next periods $t = 1, 2, \cdots, \{\gamma_t\}_{t \in \mathbb{N}}$ converges in the total variation norm to γ_*, at a geometric rate.

Having established that the process of available supplies has a unique invariant distribution which is a global attractor, the fact that $p_t = p(z_t) = F(z_t - x(z_t))$, implies that the same holds for the Markov process of prices. □

Proof of the Remark

Proof. The facts that $F(0) = +\infty$ and $\omega_{t+1} = 0$ with positive probability, imply that if the initial available supply z_0 is positive (equivalently if the initial price p_0 is finite), then $x(z_t) > 0$, $z_t > 0$ with probability one, for all time t, and

$$p_t + k \ = \left(\frac{1-d}{1+r}\right) E_t p_{t+1}, \quad \forall\, t \geq 0.$$

Therefore,

$$E_0 p_t \geq \left(\frac{1+r}{1-d}\right)^t krightarrow \ +\infty, \quad \text{as } t \to +\infty.$$

This last fact together with the fact that the distribution of prices converges to a unique invariant distribution which has no atom at $+\infty$, imply that $\lim_{t\to+\infty} Var[p_t | p_0] = +\infty$.

Given any initial distribution γ_0 for z_0,

$$E[p(z_t)] \ = \ \int_S p(z_t)\gamma_t(dz_t) \ = int_S E[p(z_t)|z_0]\gamma_0(dz_0) \ \to \ +\infty, \quad \text{as } t \to +\infty.$$

Choosing $\gamma_0 = \gamma_*$, we conclude that the invariant distribution for the price process has infinite mean.

Finally, as $E[p_t] \to +\infty$, and considering that the distribution of prices converges to the unique invariant distribution which has no atom at infinite, we conclude:

$$\begin{aligned} &\forall\, \varepsilon > 0, \forall\, p' > 0, \quad \exists\, T \in \mathbb{N}, \exists\, p \geq p', \quad \text{such that:} \\ t \geq T \quad &\Longrightarrow \quad E[p_t] > p, \quad \text{and} \quad \text{Prob}[p_t < p] \geq 1 - \varepsilon. \end{aligned}$$

□

Proof of the Proposition

The proof follows the structure of the proof of Proposition 1 in Deaton & Laroque (1996).

Consider the base model with discount rate r, stocks deterioration parameter d, constant marginal and average storage cost k, supply shocks ω_t, and inverse consumption demand F. By Theorem 1, there exists a unique stationary rational expectations equilibrium $p(z)$ characterized by:

$$p(z) = \max\left\{\left(\frac{1-d}{1+r}\right) Ep(\omega + (1-d)x(z)) - k,\, F(z)\right\} \tag{9}$$

where

$$x(z) = \begin{cases} z - F^{-1}(p(z)), & \text{if } z < z^* \equiv \inf\{z : p(z) = 0\} \\ z^* - F^{-1}(0), & \text{if } z \geq z^* \end{cases} \tag{10}$$

Consider the alternative model with discount rate r, stocks deterioration parameter d, constant marginal and average storage cost k, supply shocks $\widetilde{\omega}_t \equiv \sigma\omega_t + \mu$, inverse consumption demand $\widetilde{F}$ satisfying $\widetilde{F}(\sigma z + \mu) = F(z)$, and unique stationary rational expectations equilibrium $\widetilde{p}(\tilde{z})$.

Let $p_1(z) \equiv \widetilde{p}(\sigma z + \mu)$. It suffices to prove that p_1 satisfies the functional equation (9)-(10)

Proof. If $z < z_1^* \equiv \inf\{z : p_1(z) = 0\}$, then

$$\begin{aligned} Ep_1\Big(\omega + (1-d)\Big(z - F^{-1}(p_1(z))\Big)\Big) &= E\widetilde{p}\Big(\sigma\Big[\omega + (1-d)\Big(z - F^{-1}(\widetilde{p}(\sigma z + \mu))\Big)\Big] + \mu\Big) = \\ = E\widetilde{p}\Big((\sigma\omega + \mu) + (1-d)\sigma\Big(z - F^{-1}(\widetilde{p}(\tilde{z}))\Big)\Big) &= E\widetilde{p}\Big(\widetilde{\omega} + (1-d)\Big(\tilde{z} - \big(\widetilde{F}\big)^{-1}(\widetilde{p}(\tilde{z}))\Big)\Big), \end{aligned}$$

where $\tilde{z} \equiv \sigma z + \mu$. Therefore,

$$\begin{aligned} &\max\left\{\left(\frac{1-d}{1+r}\right) Ep_1\Big(\omega + (1-d)\Big(z - F^{-1}(p_1(z))\Big)\Big) - k,\, F(z)\right\} = \\ &= \max\left\{\left(\frac{1-d}{1+r}\right) E\widetilde{p}\Big(\widetilde{\omega} + (1-d)\Big(\tilde{z} - \big(\widetilde{F}\big)^{-1}(\widetilde{p}(\tilde{z}))\Big)\Big) - k, \widetilde{F}(\tilde{z})\right\} = \\ &= \widetilde{p}(\tilde{z}) = \widetilde{p}(\sigma z + \mu) = p_1(z). \end{aligned}$$

If $z \geq z_1^*$, then

$$\begin{aligned} &Ep_1\left(\omega+(1-d)(z_1^*-F^{-1}(0))\right)= \\ &=E\widetilde{p}\left(\sigma\left[\omega+(1-d)\left(z_1^*-F^{-1}(0)\right)\right]+\mu\right)= \\ &=E\widetilde{p}\left(\widetilde{\omega}+(1-d)\left(\tilde{z}^*-\left(\widetilde{F}\right)^{-1}(0)\right)\right). \end{aligned}$$

Therefore,

$$\begin{aligned} &\max\left\{\left(\frac{1-d}{1+r}\right)Ep_1\left(\omega+(1-d)(z_1^*-F^{-1}(0))\right)-k,\ F(z)\right\}= \\ &=\max\left\{\left(\frac{1-d}{1+r}\right)E\widetilde{p}\left(\widetilde{\omega}+(1-d)\left(\tilde{z}^*-\left(\widetilde{F}\right)^{-1}(0)\right)\right)-k,\widetilde{F}(\tilde{z})\right\} \\ &=\widetilde{p}(\tilde{z})=\widetilde{p}(\sigma z+\mu)=p_1(z), \end{aligned}$$

where $\tilde{z}^* \equiv \inf\{\tilde{z}:\widetilde{p}(\tilde{z})=0\}$. □

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Chapter 16

The role of low stocks in generating volatility and panic

Matthieu Stigler and Adam Prakash[1]

The purpose of this study is to investigate non-linearities in the relationship between agricultural commodity prices, using wheat futures from the Chicago Mercantile Exchange (CME) and wheat inventories of the world's leading wheat exporter - the United States of America - relative to disappearance.[2] The underlying notion of our research is that in modelling volatility, one should take into account the presence of different volatility regimes, and to determine in what manner and to what extent do expectations about future inventories (as an indicator of prospective market "tightness") influence those regimes.

For this purpose, we employ a volatility regime-switching model. Results show that in the absence of market tightness, commodity prices do not appear to be influenced by inventories. However, when inventories fall low, commodity prices become highly linked to information on stocks, and especially to supply and demand disturbances that reduce the stocks-to-disappearance ratio further. Conversely, low volatility regimes emerge when stocks are in abundance.

Introduction

As seen in earlier chapters, among potential sources of market volatility, stocks have been instrumental in moderating or amplifying volatility, and are viewed by policy-makers as key to buffering market turbulence. Indeed, stocks have played an important role in price stabilization policies in the past, and remain topical today in discussions about achieving food security. For example, the announcement of the release of Japanese rice security stocks is thought to have acted as a depressant during the rice spike (Dawe, 2010). Therefore, it is not surprising that the usefulness of holding public stocks has been the subject of debate by scholars in recent years - see Timmer (2010) and von Braun & Torero (2009). This chapter focuses on the impact of new information on stocks and its subsequent impact on price dynamics. The analysis contributes to understanding how periods of extreme volatility can arise in commodity markets.

In discussions of the role of stocks in generating market turmoil, a comprehensive understanding of the relationship between inventories and price dynamics is required. The

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2 "Disappearance" is measured by domestic utilization plus exports.

econometric approach of time series decomposition in Chapter 5 supported the significance of this link, but several economists remain less than convinced about the empirical importance of the relationship, both in the short- and long-term. For instance, Dawe (2009) concludes that the link between volatility and world rice stock levels was rather weak during the 2006-08 event. Roache (2010), who used data from the last one-hundred years, came to a similar finding that long-term volatility in commodity prices is not influenced by commodity stock levels.

More generally, there is a significant body of theoretical literature, centred on the *competitive storage model*, which views inventories as the main determinant in commodity price behaviour. While this book devotes due attention to the storage model, with a comprehensive description in Chapter 15 and a discussion of its predictive power for the dynamic properties of commodity prices in Chapter 2, our task here is to investigate the storage model's implications for price volatility.

The storage model, introduced in the pioneering work of Gustafson (1958) and further developed by Samuelson (1971), Scheinkman & Schechtman (1983), Wright & Williams (1982, 1984) and Deaton & Laroque (1992), studies whether or not speculators[3] will store a commodity depending on its expected price at the next period. A key issue is recognizing that storage cannot be negative, i.e. one can subtract a commodity from the present to deliver it in the future, but one cannot borrow a commodity produced in the future and deliver it in the present.

This constraint introduces a non-linearity, where price behaviour radically changes between periods where stocks are held and periods when they are not. Periods of positive stocks appear when the actual price is below its future expected value. In this regime, speculators store the commodity; by doing so, they introduce auto-correlation in the price although the supply is assumed to be independent and identically distributed (i.i.d.). But when the price is unusually high, and hence expected to be lower in the next period, incentives to store vanish, leading to a "stock-out" during which prices simply follow the assumed i.i.d. process.

Figure 16.1 illustrates this phenomenon in the Chicago Mercantile Exchange (CME) wheat market, data for which are used in this study. The non-linear behaviour of the (futures) prices tending to be exceptionally high with forecasts of low stocks (relative to expected disappearance) can be clearly seen.

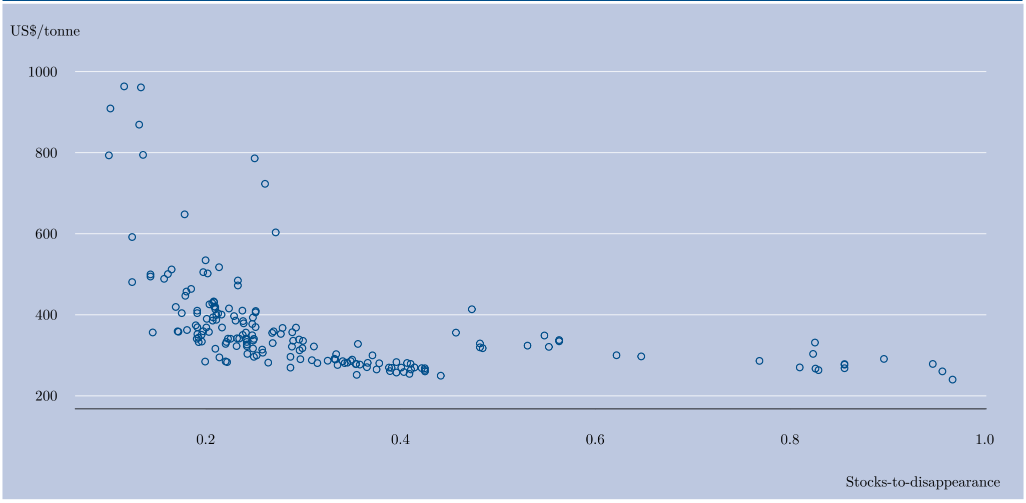
Volatility dynamics follow a similar scheme, as they are seen to differ between regular and stock-out regimes. In the regular regime, volatility is found to increase with the price level. Conversely, in the stock-out regime dominated by i.i.d supply, the conditional variance of prices is constant regardless of how high prices are.

The storage model's prediction that volatility is constant in stock-out periods may at first seem surprising, given that one would expect that in a regime in which stocks are absent, any small supply or demand disturbances would lead to exceptional upward price movements. However, it is important to stress that the competitive storage model's basis is in explaining inter-crop year fluctuations only, as it models a world in which production occurs at each and every period. Thus, the prediction of constant volatility stemming from the competitive storage model concerns the comparison between years, and not within years.

In addition, using an annualized data set leads to a significant reduction in the number of observations, which potentially discards key information revealed by more frequent data that

[3] In this chapter, the term speculator refers to those agents who physically store the commodity, including commercial agents.

Figure 16.1: Stocks-to-disappearance forecasts and futures prices (US wheat)



are often at one's disposal. A second problem concerns the measurement of stocks. Because stocks are held by speculators, their levels are not publicly known, and available annual estimates are only imperfect approximations. Moreover, the imprecision of approximated stock levels is compounded by the fact that they are often derived as a residual that balances the supply and demand identity.

As a consequence, we move our analysis in a slightly different direction from the competitive storage model. Rather than asking whether stocks affect (annual) wheat price volatility, we examine whether the reaction of traders to official announcements on expected wheat stocks-to-disappearance affect price volatility, and more importantly, whether responses to announcements are conditioned by market sentiment. Simply put, we focus on how the market reacts to stock forecasts. There are several advantages to our approach. First, it addresses and circumvents the issue of using annual stock variables in balance sheets, as analysts typically do. Annual measures of stocks are misleading, because being *ex post*, they are unknown by market participants at the time, and thus have no direct influence on agents' current behaviour.[4] By contrast, through using stock forecasts instead of *ex post* stock numbers, we are able to claim that these variables were used in trading decisions and therefore pertinent to price determination over the sample, including volatility outcomes. In taking this methodological approach, we follow the advice of Schwager (1984), who notes that:

> *It is frequently possible to build a more accurate model using past estimates rather than actual statistics as the price explanatory variables. For example, if we are trying to construct a model to explain and predict October-December prices for a given commodity, we might find that past supply estimates released during the October-December period are more helpful than the actual supply statistics in explaining historical price variation. Such price behaviour would merely reflect that what the market thought was true in the past was more important in determining prices than what was actually true (as defined by the final revised estimates).* (Schwager, 1984, p. 58)

4 This is certainly true for end-of-year (season) stocks, while for the previous year's (season's) stocks, the information content and its relevance would be conceivably "stale".

We employ stocks-to-disappearance forecasts published by the official institution of the world's leading grain exporter: the World Supply and Demand Estimates (WASDE) published by the United States Department of Agriculture (USDA). A further advantage of using the WASDE forecasts is that higher frequency - monthly- data may be employed, to arrive at more meaningful hypotheses. But, even though using data of a higher than annual frequency is more appropriate to investigate volatility, by using daily price data we still end up with a frequency discrepancy in our sample. The importance of using daily price data is that it embodies precise information on market behaviour at the time of a specific WASDE announcement. Therefore, as our primary focus is to assess the market reaction to new information on stocks, we retain daily price data, and choose to treat monthly stock expectation data as a latent variable.

Moving forward to the empirical analysis, the following section presents our modelling framework and methodological issue. After which, we explain how the data series employed in the analysis are constructed, and then we report on our results. Finally, some concluding thoughts are presented.

How do stock forecasts affect the market volatility?

Econometric practitioners usually model the conditional volatility of returns by employing the Autoregressive Conditional Heteroskedasticity (ARCH) model initially introduced by Engle (1982), and its variants. In its basic form, the ARCH model specifies the conditional variance as dependent on the previous squared innovation of the series. Bollerslev (1986) generalized the ARCH model by allowing the conditional variance to depend also on previous conditional variance levels. This modification, which leads to a more parsimonious parameterization of the model[5], is known as GARCH (1,1):

$$\begin{aligned} y_t &= f(y_{t-1}) + u_t \\ u_t &= \epsilon_t \sigma_t \\ \epsilon_t &\sim \mathcal{D}(0,1) \\ \sigma_t^2 &= \omega + \alpha u_{t-1}^2 + \beta \sigma_{t-1}^2, \end{aligned} \tag{1}$$

where, to ensure a positive variance, one constrains $\omega \geq 0$ and$\alpha, \beta > 0$. Stationarity of the variance process is imposed through: $\alpha + \beta < 1$. $\mathcal{D}(0,1)$ is an arbitrary independent and identical distribution[6] with mean and variance equal to 0 and 1, respectively. f is a simple "filtering" function to remove possible auto-correlation of the log-returns, and y_t is the log-return series.

The GARCH framework has spurred significant interest in theoretical and empirical research, and this model class (along with its extensions) is now used widely to forecast commodity price volatility. If stock data were available at the same frequency as prices, it would be straightforward to investigate the effect of stocks on volatility by adding a further term in equation (1). This is not a feasible option though, as only monthly stock data are available. While a simple solution would be to insert a dummy variable taking value 1 when stock forecasts are available, and 0 if not, this approach lacks a suitable theoretical underpinning as it does not acknowledge the possibility of regime-switching behaviour as predicted by the storage model.

5 It can be shown that a GARCH(1,1) is equivalent to an ARCH(∞).

6 Typical choices for the distribution include the normal or the student, the latter is employed in the analysis.

The approach we therefore adopt is more theoretically consistent: because we acknowledge that the storage model predicts the presence of two regimes, we employ a regime-switching GARCH model when estimating volatility. That is, we investigate how volatility differs in periods of low stocks compared with periods of high stocks. This could be accomplished by using a threshold GARCH model, where the stock series variable determines the switching between two GARCH regimes. But because stock forecasts are observed only at a monthly frequency, we instead treat them as a latent variable. This requires us to model the switching process between regimes through a latent process that is assumed to follow a first-order Markov process. From hereon, we investigate the relationships between the stock series and the estimated switching process. Importantly, this enables us to conclude whether the model supports the hypothesis that changes in stocks lead to regime-switching.

We recognize a drawback of the approach in that it models the switch in regimes as the outcome of an unobserved a latent process, and so results are less precise about the determinants of the switching process. Indeed, it is not possible to infer with confidence whether stock changes lead to regime-switching, or whether this phenomenon is attributable to other variables.

The Markov-switching GARCH Model The Markov-switching model, introduced in econometrics by Hamilton (1989), describes a regime-switching regression where the transition between regimes is driven by a latent discrete Markov chain. In other words, the model parameters switch from one regime to another according to an unobservable process that is assumed to follow a first-order Markov process. Formally, the probability of the *state variable* S_t being in regime $i \in \{1,\ldots,N\}$ only depends on its previous state:

$$P(S_t = i|S_{t-1} = j, S_{t-2}, \ldots, S_0, \Omega_{t-1}) = P(S_t = i|S_{t-1} = j) \equiv p_{ji}, \tag{2}$$

where Ω_t is an information set at time t containing variables other than S_t. Typically, one considers only a restricted number of regimes N, in the present case only two.

Markov-switching models have been used in linear regression and autoregressive frameworks (Hamilton, 1990, 1991). An extension of the Markov-switching AR to the GARCH framework was provided by Hamilton & Susmel (1994). In this context, coefficients of Equation (1) can change depending on the state of the latent variable S_t. While appealing, the approach poses a considerable challenge for estimation. Hamilton & Susmel focused on a Markov-switching ARCH, because introducing a GARCH component creates a complicated path of dependence where the variance at time t depends on the entire history of the process. Haas et al. (2004), however, circumvented this problem by using a different specification, where the switching is assumed to occur between several conditional volatility processes. Because we are now dealing with two different volatility processes, the path-dependence problem is avoided allowing us to include GARCH components. This leads to the following equation:

$$\sigma^2_{t,i} = \omega_i + \alpha_i u^2_{t-1} + \beta_i \sigma^2_{t-1,i}. \tag{3}$$

Several insights can be gained by employing the Markov-switching GARCH (hereafter MS-GARCH) model. Firstly, because its specification allows periods of high and low unconditional volatility to be clearly identified, we can accurately estimate both regime probabilities as well as of the average duration of each regime. Secondly, regime probability estimates can be further used for comparison with the stocks variable, which allows an investigation on whether the stocks is attributed as the cause of switching behaviour.

A third advantage is that the MS-GARCH model is robust against changes in market conditions. Indeed, as Lamoureux & Lastrapes (1990) have shown, the single-regime GARCH model (1) tends to significantly overestimate volatility persistence in the presence of structural changes. This is precisely what motivated Hamilton & Susmel (1994) to develop the MS-ARCH model. The model avoids the bias of GARCH effects by allowing the coefficient on the unconditional volatility level to switch between regimes. When applied to a history of equity returns in the United States of America, during which equity markets underwent a significant crash in October 1987, the MS-ARCH model led to a significantly lower volatility persistence. Furthermore, the model was able to provide more accurate forecasts than those provided by a range of single-regime GARCH models.

MS-GARCH: Extension to GJR Another issue raised by the analysis is the question of asymmetry in volatility responses. As Chapter 2 illustrates, volatility tends to respond differently to positive shocks than to negative shocks. Interestingly, while in traditional financial asset markets negative shocks impact to a greater extent volatility (referred to as the leverage effect), in agricultural markets it is positive shocks that tend to drive greater volatility. This phenomenon, discussed more thoroughly in Chapters 1 and 2, is explained by the storage model, which posits that positive shocks will assume a contraction in stocks, in turn generating an increase in volatility.

One of the simplest ways to measure such asymmetric effects is to use the GARCH-GJR model (named after Glosten et al., 1993). These authors estimated positive and negative shocks in a separate manner through the following equation:

$$\sigma_t^2 = \omega + \alpha^+ u_{t-1}^2 \mathrm{I}(u_{t-1} > 0) + \alpha^- u_{t-1}^2 \mathrm{I}(u_{t-1} \leq 0) + \beta\sigma_{t-1,}^2 \tag{4}$$

where α^+ and α^- are positive and 'I' is an indicator function.

Asymmetry is tested for by comparing the α^+ and α^- coefficients. Integrating the so-called "GJR effect" into each regime of the MS-GARCH model is amenable. Doing so provides insights about whether the asymmetric effect is different in periods of either low and high volatility. Intuitively, the effect should be less pronounced in the low volatility regime, where a price shock does not ostensibly affect the level of inventories.

Modelling with MS-GARCH While Equation (3) of the MS-GARCH specifies that all coefficients can change between regimes, this need not be the case. It is indeed possible to use a simpler model where, for example, only the constant in the GARCH equation switches between regimes. Using this model has several advantages. Firstly, it allows for easier comparison and interpretation of regime dynamics, as there is only one parameter switching. Moreover, it reduces the computational burden encountered by the fully flexible specification of (3).

The model is estimated by direct maximization of the log-likelihood function, which is obtained by using the BEKK filter (Krolzig, 1997). Arriving at an estimation procedure is nevertheless a challenging task as both the parameters and the regime probabilities need to be estimated simultaneously. A further complication arises when the desire is to test for the presence of Markov-switching effects. Indeed, one is then confronted with the so-called "problem of non-identified parameters" under the null hypothesis (Andrews & Ploberger, 1994), as well as zero scores (Garcia, 1998).

While Carrasco & Hu (2004) and Hu & Shin (2008) have proposed several solutions that allow testing for Markov-switching, it is unclear whether their solutions can be applied to the framework of Haas et al. (2004) we adopt here. Therefore, we resort to a methodology that uses a more straightforward information-criterion based comparison, which has been shown to produce robust results in many different settings (see among others: Gonzalo & Pitarakis, 2002 in the similar case of threshold regime-switching models, and Aznar & Salvador, 2002 for determining the cointegration rank). In the same vein, we also employ an information-criterion procedure instead of standard statistical tests to compare MS-GARCH models with different parameterizations (i.e. the presence of GJR effects and whether all coefficients switch or not).

Finally, a few words ought to be said regarding our distributional assumptions. An interesting feature of GARCH models is that even if a symmetric normal distribution is assumed for $\mathcal{D}$ in (1), the unconditional distribution can exhibit excess kurtosis. Nevertheless, the normal distribution inadequately describes the fat-tails of the error distribution that is typically observed in financial variables. A simple solution therefore is to use the Student distribution instead (see Bollerslev, 1987), which is better suited for fat-tailed distributions. The distribution's degrees of freedom are estimated from the data, and could even be assumed to switch between regimes, as in Dueker (1997). However, this flexibility is not without cost, namely in the difficulty in interpreting and comparing results. Having described our modelling approach, we now turn to a discussion of the data employed and the results from estimation.

Data and estimation

Data

As previously mentioned, our inventory data constitute end-of-season forecasts for both the current and following year published in the USDA's monthly WASDE report. Our analysis uses the stock-to-disappearance ratio. Thus by "stocks" we refer formally to this ratio.

Figure 16.2 shows stocks-to-disappearance forecasts for wheat over the period 1970-2010. Because there can be two forecasts per month (actual and following year), years are shown in different colours – dark and light blue – for the sake of clarity. The final realized value (corresponding to the end-of-year stocks-to-disappearance) is indicated by a black circle. Interestingly, WASDE forecast accuracy does not seem to have been affected by volatility in business cycles, especially economic crises: typically, forecast errors do not seem to differ from the previous years.

Figure 16.3 shows USDA forecasts for the current year against the futures price for wheat reported on the day of the forecast release. Visually, there appears a highly negative relationship between the two series.

When constructing the stock series, we always used the subsequent end-of-season forecast: published from January to August (since September is considered to mark the end of the season) for the current year, and then September-December reports for the following year. Admittedly, this implies a certain heterogeneity in the forecast horizons: while the August report forecasts prices for the next month, the November or December report forecasts prices for almost one year ahead. This heterogeneity means that forecasts are likely not to have the same impact: the market probably reacts more to forecasts close to the end season than to those for longer horizons.

Regarding the price series, as shown in Figure 16.3, we use daily futures data from CME from January 1985 to January 2009 (6 000 observations in total). Here, construction of the series is more standard, although one should, when constructing such price series, keep in

Figure 16.2: WASDE wheat stocks-to-disappearance forecasts for US: 1970-2010

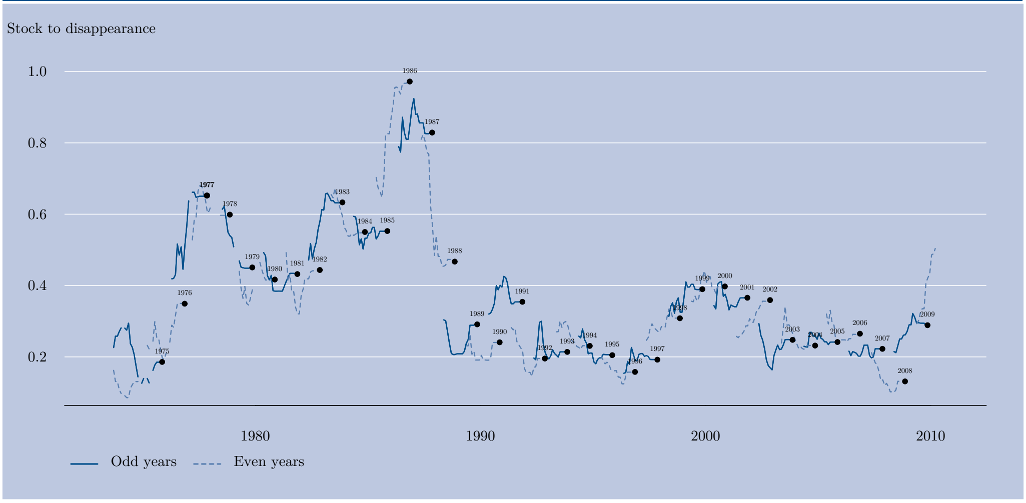
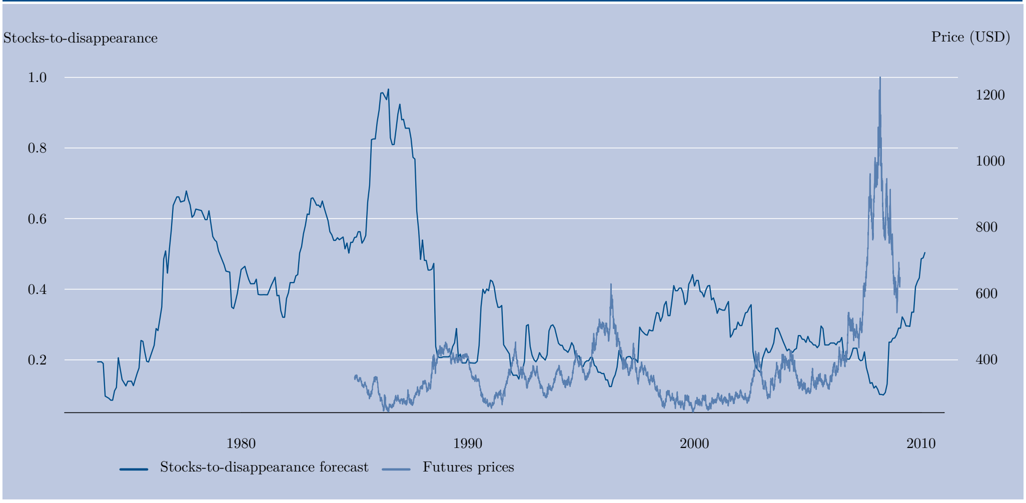


Figure 16.3: WASDE wheat stocks-to-disappearance forecasts for US and CME wheat futures prices



mind the so-called Samuelson (or maturity) effect. The maturity effect states that volatility of the futures price tends to increase when the maturity date approaches, see Chapter 2 for a more detailed discussion. To avoid the "artificial volatility" introduced by the maturity effect, we created a synthetic futures series with a constant maturity of 100 days rather than the nearby maturity.[7]

7 This is done by spline-interpolating the 100 day-maturity price based on available maturities for each observation.

Table 16.1: GARCH model results

	Estimate	Std. Error	t value	Pr (>|t|)
ω	0.02	0.01	3.73	0.00
α	0.05	0.01	8.27	0.00
β	0.94	0.01	123.46	0.00
ν	12.33	1.58	7.81	0.00
AIC:	21805.69			
NLL	10648.85			
Persistence	0.991			
Uncond. variance	0.02			

Results

As conventional unit root tests have indicated our price series is non-stationary, we investigate the volatility of the log-returns, as is commonly employed in the financial literature. We first estimate as a benchmark, a simple GARCH model with Student errors:

$$\sigma_t^2 = \omega + \alpha u_{t-1}^2 + \beta \sigma_{t-1}^2 \tag{5}$$

Results are shown in Table 16.1. All parameters were found to be statistically significant. The persistence of the estimated variance (given by $\alpha + \beta$) is close to 1 at 0.991, as is typically found for high frequency series. The corresponding unconditional variance is then 0.02.

When GJR parameters are introduced, we find that the coefficient α^+ for positive shocks is higher than α^- for negative shocks (0.06 compared with 0.03), confirming the results of Carpantier (2010). Testing for the inequality of $\alpha^+ > \alpha^-$ is complicated, as inequality tests that involve two or more coefficients have non-standard distributions. Hence, we resort to a simple comparison of the 99% confidence intervals of both parameters. These intervals do not overlap, indicating α^+ is statistically higher than α^-.

Introducing now Markov-switching effects in the GARCH model, we turn to the simpler specification where only ω_i in (3) can switch, while the other parameters remain constant:

$$\sigma_{t,i}^2 = \omega_i + \alpha u_{t-1}^2 + \beta \sigma_{t-1,i}^2 \tag{6}$$

In this model, the persistence (given by $\alpha + \beta$) is the same in each regime, but the unconditional volatility $\omega_i / (1 - \alpha - \beta)$, can differ depending on the regime.

Results of the MS-GARCH with ω switching are shown in Table 16.2. Interestingly, we see that the unconditional variance is much higher (0.19) in the second regime compared with the first (0.009). Turning to the transition probabilities, we obtain the following matrix:

$$\begin{pmatrix} 0.991 & 0.009 \\ 0.133 & 0.867 \end{pmatrix}$$

While the first regime appears to dominate (with a probability of 99 percent of dwelling in this regime), the second regime is also persistent with a probability of remaining within, as high as 86 percent.

Table 16.2: MS-GARCH with ω switching				
	Estimate	Std. Error	t value	Pr (>|t|)
ω_1	0.0094575	0.0029223	3.2363	0.0012108
ω_2	0.1938141	0.0535027	3.6225	0.0002918
α	0.0278933	0.0044838	6.2210	4.941e-10
β	0.9634873	0.0052218	184.5139	<2.2e-16
p_{11}	0.9913151	0.0035032	282.9707	<2.2e-16
p_{22}	0.8668888	0.0428881	20.2128	<2.2e-16
ν	28.9465468	13.4929700	2.1453	0.0319284

NLL	10636.31			
AIC	21286.62			
	Regime1		Regime 2	
Persistence	0.9913		0.9913	
Uncond. variance	0.0095		0.1955	

An interesting extension is to consider the inclusion of GJR effects and further allow all GARCH parameters to switch, which leads to:

$$\sigma^2_{t,i} = \omega_i + \alpha^+_i u^2_{t-1} \mathrm{I}(u_{t-1} > 0) + \alpha^-_i u^2_{t-1} \mathrm{I}(u_{t-1} \leq 0) + \beta_i \sigma^2_{t-1,i}. \quad (7)$$

Results are shown in Table 16.3. It is of interest to compare the different GJR dynamics between low and high regimes. The asymmetry is still found to be present, but in this instance with a much stronger impact in the high regime. Indeed, while in the low regime the impact is 0.014 (α^+_1), it switches to 0.116 (α^+_2), which represents a highly important difference. Somewhat surprising is that in the high volatility regime, negative (price-decreasing) shocks do not have any influence on volatility whatsoever: α^-_2 - the coefficient on negative shocks - is not significantly different from zero.

Figure 16.4 shows the regime-dependent news-impact curve. Two facts surface from this figure. First, the unconditional volatility level is seen to be very different in the low-volatility regime (light blue line, right axis) than in the high-volatility regime (dark blue line, left axis). Secondly, the asymmetric effect is much stronger in the high volatility regime: when volatility is already high, “bad news” (positive shocks) have a dramatic impact on volatility, where they will increase conditional volatility by 0.11 (compare to 0.02 in the low-volatility regime). Put simply, "bad news" has more than 4 times a greater impact than "good news".

Turning now to the transition probabilities, the second regime appears to be much more persistent than in the previous model, where the probability to remain in the second regime is now close to 98 percent, similar to the probability of staying in the first regime. This can also be seen in Figure 16.5, which shows the smoothed probability of the high volatility state over time, together with the original price series.

Finally, we compare the three models used based on the AIC criterion. The AIC criterion favours the last model –the MS-GARCH with all coefficients allowed to switch– to the simpler MS-GARCH and the single-regime GARCH. This suggests that indeed a Markov-switching

Table 16.3: MS-GARCH with all coefficients switching

	Estimate	Std. Error	t value	Pr (>|t|)
ω_1	1.8491e-03	8.0236e-04	2.3046	0.021188
ω_2	6.6999e-02	2.5600e-02	2.6171	0.008868
α_1^+	1.3706e-02	4.2598e-03	3.2175	0.001293
α_1^-	6.4696e-03	4.9853e-03	1.2977	0.194380
α_2^+	1.15953-01	2.5424e-02	4.5605	5.102e-06
α_2^-	2.4797e-02	1.6529e-02	1.5003	0.133549
β_1	9.8650e-01	3.3663e-03	293.0537	<2.2e-16
β_2	9.1111e-01	2.3490e-02	38.7874	<2.2e-16
p_{11}	9.8517e-01	2.3490e-02	38.7874	<2.2e-16
p_{22}	9.8239e-01	8.2463e-03	119.1310	<2.2e-16
ν	1.5357e+01	2.6222e+00	5.8565	4.728e-09
NLL	10618.21			
AIC	21258.42			
	Regime1		Regime 2	
Persistence	0.9966		0.9815	
Uncond. variance	0.0019		0.0683	

Figure 16.4: Regime-dependent news impact curve

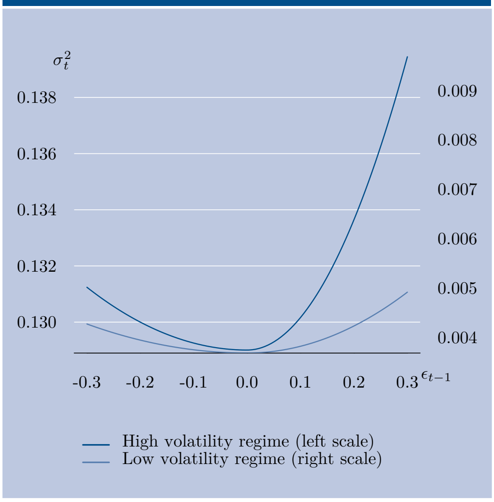
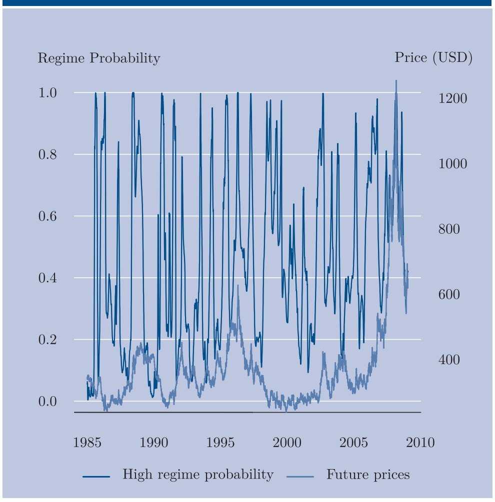


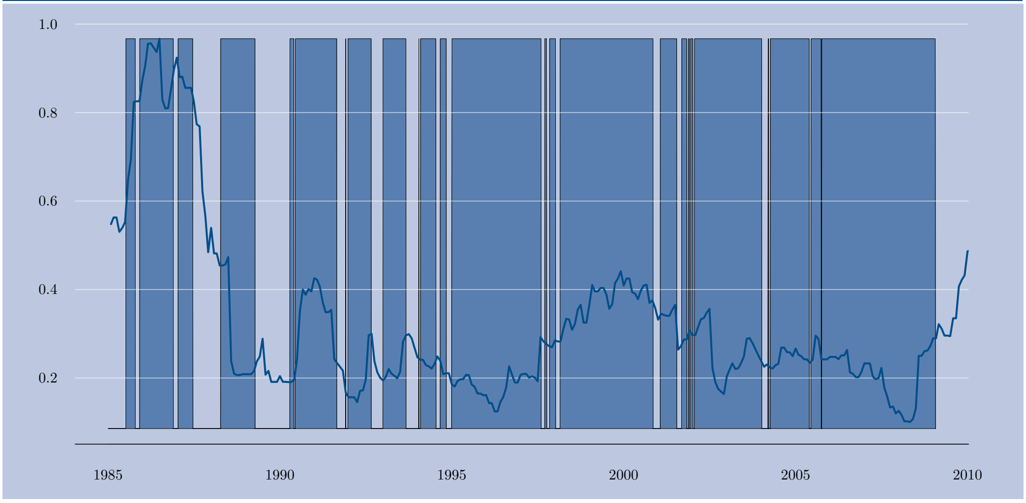
Figure 16.5: High-volatility regime probabilities



model is best suited to capture the volatility, in accordance with the prediction from the storage model.

In conclusion, using Markov-switching GARCH models, we observe two regimes characterized by significant differential volatility levels. Furthermore, once we take

Figure 16.6: Probability of remaining in high-volatility regime versus wheat stock disappearance



Note: We use here the value of 0.8 as the threshold above, which the smoothed probablity is assumed to be one, and conversely, zero below.

asymmetric effects into account, we observe that in the extreme volatility regime, bad news have a much more dramatic impact than under the quiescent regime. This suggests that the regimes reflect “market sentiment”: in periods of high volatility, even small surprises can exacerbate market tension thereby fuelling panic.

Now that we have identified different regimes of volatility, a question remains on what determines the "switch" between regimes. Within the Markov framework, this is assumed to be triggered by an unobserved latent variable. To address this, the next question is whether information on stocks-to-disappearance can be associated with the regime switches.

Comparisons of switching regimes with the stocks variable

Given that we observed Markov-switching between regimes of significant differing volatility levels in the futures price of wheat, we now seek to understand whether information on United States wheat stocks can generate the observed switching. To do so, we employ an informal approach, where a graphical comparison between stock forecasts with regime transition probabilities is first made, and then from which a simple probit model is applied. Figure 16.6 shows the graphical comparison of stock forecasts with the probability of being in the high volatility regime (in blue).

Though it is difficult to establish a direct link between the two variables, one can nevertheless observe that periods of low stocks are only present in the high regime. What is more surprising is to see that there are also periods of high stocks in the high volatility regime such as in 2000, but for the most part, periods of high stocks and high volatility have been characterized by a strong decrease, for instance in 2003 and 2004.

We now turn to the probit model, where we use only the regime probabilities in the day for which the forecast was published. It is observed in Table 16.4 that there is a strong

Table 16.4: Probit model results

	Estimate	Std. Error	z value	Pr (>|z|)
Intercept	1.12	0.16	6.95	0.00
Stocks	-0.92	0.40	-2.28	0.02

Table 16.5: Average effects model results

	Intercept	Stocks
Average effect	0.32	-0.26
At average values	0.33	-0.27
At Q3 values	0.35	-0.29
At Q1 values	0.29	-0.24

and significant negative coefficient on the stock forecast variable. Because the coefficient has no direct interpretation in the probit framework, we assess the average effects, as shown in Table 16.5.

The negative effect is confirmed, and seems robust to measures used, while varying only little among quantiles. Thus, the probit model suggests that stocks indeed have an impact on the regime-switching process: lower stocks-to-disappearance increases the probability of being in the high volatility regime.

In summary, our hypothesis that stock forecasts influence the observed switching is confirmed, albeit under this rather informal approach, in that downward forecast revisions augment the probability of being in the high volatility regime.

Conclusions

This chapter investigated the impact of USDA's forecasts of end-of-season stocks-to-disappearance on volatility in the CME wheat futures market, which is a reference point for price discovery in the global wheat market. Our enquiry was conducted in two steps. Firstly, we modelled volatility in a Markov regime-switching GARCH framework. Within the two regimes identified, we observed a significant difference in unconditional volatility levels, where volatility in the high regime ranges between 20 and 36 times greater than in the low volatility regime. Secondly, we estimated how each regime reacts to the arrival of positive and negative news on stocks-to-disappearance, drawing upon the important body of literature investigating the so-called *leverage effect*. Our results show indeed a strong asymmetry between the low and high volatility regimes. In the high volatility regime, "bad news" (i.e. a positive shock) will result in an increase in volatility, which confirms the result that volatility is 36 times stronger in order than under the low volatility regime. We propose to interpret this as "panic", where in periods of high volatility, bad news will have a much more dramatic impact on the market than otherwise.

In the second step, we enquired whether switching between regimes could be a result of changes in the USDA's stocks-to-disappearance forecasts. This was done through resorting to a graphical comparison, followed by applying a simple probit model. Based on our investigations, we observed that stock forecasts are likely to generate regime-switching: when forecasts of stocks depletion are announced by the USDA, the probability of being in the extreme volatility regime increases significantly.

The approach we adopted appears promising in shedding light on the behaviour of agricultural commodity prices and warrants deeper and more extensive enquiry. One line of research, for instance, would be to apply the analysis to other storable commodities, including those in non-agricultural markets. It would also be useful to apply the approach to asset prices, to identify if the phenomenon of volatility regimes are observable in financial markets. Another interesting avenue to explore would be to employ other proxies for inventory tightness, such as the spread between futures and spot prices as in Ng & Pirrong (1994).

As for policy, the results reveal the importance of expected stocks held by major grain exporting countries in determining episodes of elevated price volatility in food markets. It might be tempting to infer that the corollary of this conclusion would be to increase inventories *per se* to prevent turmoil. While this may be true to diffuse the prospect of isolated turbulence in domestic markets, this chapter demonstrates that ample and highly liquid commercial stocks held by major international suppliers appear a necessary and sufficient condition to instil confidence in world markets and to lessen the probability of future bouts of extreme global volatility and crises from occurring.

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Part IV

GLOBAL GOVERNANCE TOWARDS FOOD SECURITY

Chapter 17

Global governance: international policy considerations

Panos Konandreas[1]

Introduction

This chapter deals with international policy issues relevant to world price volatility in basic foodstuffs, particularly the extent to which multilateral trade rules are conducive to an environment of market stability. While it is widely recognized that achieving food security depends to a large degree on measures at the national, sub-national and individual household levels, the international context in which these policies are implemented is instrumental for the success or failure of national efforts. This is particularly the case during periods of volatile world prices, when international solidarity is needed and the trading behaviour of countries is critical on the ability of other countries to meet their own food needs.

By definition, world price volatility concerns not only the incidence of price spikes but also the opposite phenomenon of price collapses. In fact, we are able to discern episodes of high prices because we have had the experience of price troughs. While the concept of price volatility is clearly associated with both extreme events, food security concerns are often linked to episodes of high prices, i.e. when there is an immediate impact on peoples' ability to feed themselves. There is much greater visibility of the impact of high prices, which manifests itself in increased hardship for a large part of market-dependent households in poor countries, especially in politically-sensitive urban centres. However, the opposite episodes of depressed world prices, especially when prolonged, are also detrimental to food security because they slowly erode and displace otherwise viable domestic production, resulting in greater national dependency on the world market in the longer term. By and large, price spikes are a short-term concern: they affect consumers and are immediately visible. On the other hand, depressed prices are a longer-term problem: they first affect producers, but ultimately they contribute to the erosion of national food security.

Volatility in the world prices of agricultural commodities has been a perennial problem, and many approaches have been attempted to deal with it. Some aim at dealing with strictly short-term volatility, while others combine longer-term objectives, such as defending a floor price for producers (through minimum support prices) or containing excessive costs to consumers (through general or targeted food subsidies). By nature, most of the approaches are narrow and defensive in dealing with the symptoms of volatile prices by trying to mitigate their effects on domestic producers and consumers. These include border and domestic

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measures that aim at preventing shocks in the world market from being transmitted to the domestic market. However, by insulating the domestic market from the world market, the residual world market of the commodity becomes more inelastic, and in the process, volatility becomes more acute.

The detrimental effects of acting alone in commodity trade policy have been understood for some time and the merits of countries acting collectively have been well appreciated. Also clear are the important trade-offs between the extra cost required to effectively insulate the domestic market when acting alone and the benefit from supporting a collective multilateral effort in dealing with price instability.

In this context, the multilateral negotiations under the General Agreement on Tariffs and Trade/World Trade Organization (GATT/WTO) have been the dominant force shaping the international policy environment in commodity trading during the past three decades. Although agricultural commodities are currently under the Multilateral Trading System (MTS) which governs trade in goods and services, the process of integration of agriculture in that system is not yet complete. In some ways, however, the implications of this integration of agriculture are much more profound than in other sectors, as the whole array of policy instruments that governments have at their disposal (both border and domestic measures) are subject to disciplines.

This chapter reviews the relevant provisions of the Agreement on Agriculture (AoA), the multilateral trade policy rules agreed under the Uruguay Round (UR) negotiations. Rules on agriculture fall under the three pillars of the AoA: domestic support, market access and export competition, all of which contain provisions of direct or indirect relevance to price volatility. In its present form the AoA has elements that have worked well and others that have not. Depending on how specific provisions are used in practice, they may either contribute to aggravating situations of price volatility or to mitigating its effects.

In reviewing the efficacy of existing provisions of the AoA, this chapter also considers proposals that are on the table as part of the ongoing Doha Round negotiations, and we assess the extent to which they may be more effective. By and large, trade concerns and the related WTO rules continue to centre on situations of depressed prices in the world market and on the need to reform border and domestic policies responsible for excess production. In general, the WTO rules are helpful in disciplining such policies and are likely to be more effective in the future.

The multilateral WTO rules hardly address the opposite case: high world prices and underproduction in several food-insecure countries and the factors that led to it. This asymmetry very much reflects the trade concerns in agriculture for the long term, characterized by oversupply and related policies that result in cheap food prices. This situation may not continue in the future, and cause the need for trade rules to be adjusted accordingly.

Other aspects of collective international action relevant to situations of high food prices are food aid and other mechanisms that could help net food-importing, developing countries alleviate the burden of excessive food import bills. Regarding food aid, while the imperatives for such assistance are largely humanitarian and not trade related, for a variety of reasons the disciplines on food aid have become effectively intertwined with WTO agriculture rules so that developments in both areas move together. Similarly, the possible mechanisms for providing food import financing to food-insecure developing countries that may potentially be adversely affected by high prices owing to trade reforms are also intertwined with the trade rules. Hence, the roles of food aid in respect to volatility in food commodity prices, as well as the prospect of implementing relevant food import financing mechanisms, are also discussed here.

Imbalances in world food markets and WTO rules on agriculture

Agriculture became part of the overall disciplines governing trade in goods after the WTO came into force in 1995 with the conclusion of the Uruguay Round of multilateral trade negotiations. Although agriculture was never outside the GATT officially, certain exceptions for agriculture negotiated in the 1950s, primarily to suit domestic and trade policies of a handful of countries, meant that the regular GATT rules that applied to industrial goods did not apply to agriculture (Sharma, 2000a). This provided the legal cover for those who could afford it - mainly the rich countries - to apply import restrictions and subsidize production without limit, and thus create structural surpluses of mainly temperate-zone foodstuffs.

By the mid-1980s, world agricultural trade was in a state of disarray owing to the prevalence of these production and trade distorting policies in a number of developed countries.[2] Structural surpluses had to be disposed of somehow, and export subsidies and food aid turned out to be the key instruments to accomplish this. This was an era characterized by cheap food policy. However, while this state of affairs may have suited some countries - both exporters and importers who were subsidized - it came at the cost to longer-term food security prospects of several countries, particularly many developing countries which, as "beneficiaries" of cheap food, ignored the development of their own agriculture. The seeds of substantial shifts in consumption habits and greater dependence on world food markets had been sown. Also, the growing dependence of a large number of countries on a narrow basket of traded foodstuffs carried with it the risk of greater market volatility when the initial conditions of plenty that promoted this situation were no longer valid.

As trade wars escalated in the 1980s, calls for reforming world agricultural trade intensified in many countries (even in the perpetrator countries for budgetary or other reasons) and in the international community at large. It was against this backdrop that the Uruguay Round was launched in Punta del Este in 1986. In agriculture, the main aim of the negotiations was to address long-term imbalances by bringing more discipline and predictability to world agricultural production and trade, as well as to reduce instability in world agricultural markets. The market stabilizing effect of trade openness was expected to come about by, *inter alia*, greater price transmission to domestic markets and thus greater producer and consumer responsiveness to world price changes, more transparency and consistency on the part of governments in domestic measures (including stockholding) and trade policies, and increased confidence in the multilateral trading system as a secure source of supplies when needed.

The Uruguay Round AoA has been an important step in reforming world agriculture. However, recognizing past difficulties in bringing agriculture under multilateral disciplines, what was put in place was only the first step and left much to be desired, especially in measures dealing with world market volatility. By and large, the AoA rules responded to the perceived problems in world agricultural trade prior to the UR, which was a period characterized by overproduction owing to distorting policies in a number of developed countries. Thus the main thrust of the AoA rules was to limit the subsidization that had led to depressed prices. On the other hand, problems associated with underproduction and associated high prices were of less concern.

The benefits of a multilateral trading system depend on how trade participants adhere to the agreed rules. Many of the AoA rules were incomplete and not strictly enforceable. The ongoing Doha Round negotiations have tried to address some of these problems within

2 See Johnson (1973), Hathaway (1997), Josling et al. (1996) and Tyers & Anderson (1992).

the existing architecture of the AoA. Yet as will be seen below, even assuming that the Doha Round comes to a conclusion by accepting what is on the table, significant asymmetry in the rules will remain regarding provisions dealing with exporting and importing country interests. In essence, the AoA - with or without Doha - remains a set of rules to discipline situations of overproduction and cheap food and much less to address difficulties that countries face in cases of global scarcity and high food prices.

A key consideration in judging the adequacy of the AoA rules, either those already in place or those that will emerge after the conclusion of the Doha Round, is the nature of world food markets in the years to come. Although depressed prices have been predominant in world markets in the past, this has not always been the case, certainly not in the eyes of all participants in the world food market.

In fact, since 1970, i.e. over a period of about 40 years, there have been six episodes of high food prices, i.e. spikes in world food prices and soaring food import bills. These were in 1974-76, 1980-82, 1988-90, 1995-97, 2007-08 and now (2010-?), each lasting for about two years for a total of 12 years, or about 30 percent of the time. For the remaining 70 percent of the time, world food prices and food import bills could be said to be on trend or depressed.

An additional issue is whether this characterization of the world food market as episodes of high and low food prices will be valid in the future. Many commentators[3] believe that the era of cheap food is over and the future will see much tighter food markets (owing to population and income growth, constraints to productivity, biofuels[4], etc.). In a scenario of tighter world markets, not only will food prices and food import bills be high, but spikes may be more frequent, that is, more frequent than 30 percent of the time as has been the case in the last 40 years. If so, the legitimate questions is to what extent WTO agricultural rules, designed primarily for an era of cheap food, are equally adequate to address the opposite problem of expensive food and food crises.

With this background in mind, our discussion of the WTO rules below is structured according to the two acute world price situations - periods of depressed world prices (cheap food) and periods of price spikes (expensive food). We also assess the effectiveness of existing rules in their actual application, drawing from recent and past experience as appropriate. The new rules envisaged under the Doha Round (as they presently stand in the Draft Modalities, see WTO, 2008) are also treated.

WTO rules to defend against depressed world prices There is a variety of reasons that world food markets are not always in balance. Aggregate food production can outstrip aggregate effective demand either because of technological change or through support policies in major producing countries. Additionally, prices may be under increased pressure in years of exceptionally good harvests. Often, when world prices are depressed, governments feel compelled to put policies in place that will cushion their adverse effect on domestic production.

In general, there are two broad categories of WTO compatible policy options against depressed world prices:

3 See OECD-FAO (2010) and Headey & Shenggen (2010).

4 An important new dimension in price trends and price volatility of agricultural commodity markets is the growing linkage with energy markets. First, there are direct own price links on the supply side; second, there is an indirect price transmission through substitutes on the supply side; and third, there is price transmission through the demand side. With rising energy prices and a growing degree of market integration of energy and agricultural feedstock markets, both the levels and variability of agricultural commodities will increasingly be determined by those of energy prices (see Schmidhuber, 2007).

- border measures, i.e. raising tariffs, as long as they are within the country's bound tariff commitments at the WTO;
- domestic support measures, i.e. providing price and non-price support to farmers, again within the bound levels of its WTO domestic support commitments.

Border measures

Raising tariffs within bound ceilings

The AoA introduced a fundamental change regarding border measures from a situation where a myriad of non-tariff measures impede agricultural trade flows to a regime of bound tariff-only protection[5] plus the commitment to gradually reduce such tariffs. All countries were obligated to bind their tariffs: developed countries had to use the tariffication process[6] while developing countries were able to offer "ceiling bindings" instead. Many developing countries opted for the latter choice and in the process bound their tariffs at relatively high levels in relation to the actual applied tariffs at the time, a situation described as tariff overhang (or "water" in the tariffs).

A large tariff overhang implies greater flexibility in increasing tariffs up to the bound levels in years of depressed prices. As long as this policy is applied on a Most Favoured Nation (MFN) basis, it is compatible with WTO rules.

In general, African countries have afforded themselves much more room between bound and applied tariffs. Bound tariffs for agricultural products in Africa average some 80 percent, compared with average applied tariffs of 17.7 percent (2009), leaving an average overhang of over 60 percent. Another region with ample room between bound and applied tariffs (over 50 percent) is Central America and the Caribbean, followed by Asia (36 percent) and Latin America (30 percent). At the other extreme, the newly acceded countries (NACs) in the European region have very little room to manoeuvre (with an overhang of just 3 percent).

In general, all of the NACs in all regions have very little flexibility in raising tariffs because their tariffs are bound at levels very close to those actually applied. Figure 17.3 reflects the diversity of country situations for the different regions. It is clear that in every region there are countries where the option of increasing applied tariffs is limited. Even in Africa, with its large overall tariff overhang, there are several countries with very little flexibility in increasing tariffs without violating their WTO obligations. It is these countries that may be in need of other instruments (safeguards) to allow them a certain degree of protection in years of depressed world prices (more on this below).

In practice, even for countries that have ample flexibility in raising tariffs, such a policy may have its limitations. Higher tariffs imply higher prices received by domestic producers but also higher prices paid by domestic consumers; often such policies are politically unpalatable. Many developing countries with large numbers of poor households resist a policy of imposing higher taxes on food, even in years of depressed prices. There are, however, some possible remedies for this dilemma, whereby customs revenues generated from tariffs could be used to target food-insecure households. This option requires good administrative capacity to identify households in need (thus minimizing leakages) and infrastructure to implement resource transfers in a cost-effective manner.

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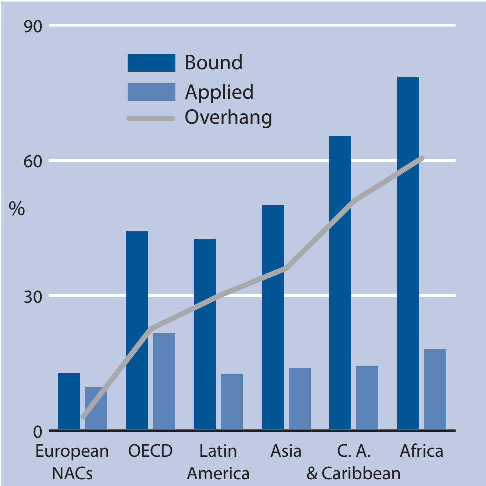
5 As per Article 4.2 of the AoA, "Members shall not maintain, resort to, or revert to any measures of the kind which have been required to be converted into ordinary customs duties, except as otherwise provided for in Article 5 and Annex 5." Article 5 covers the Special Safeguard (SSG) clause of the AoA (see below) and Annex 5 provides for certain exemptions under very specific circumstances and with an obligation of increased minimum access commitments.

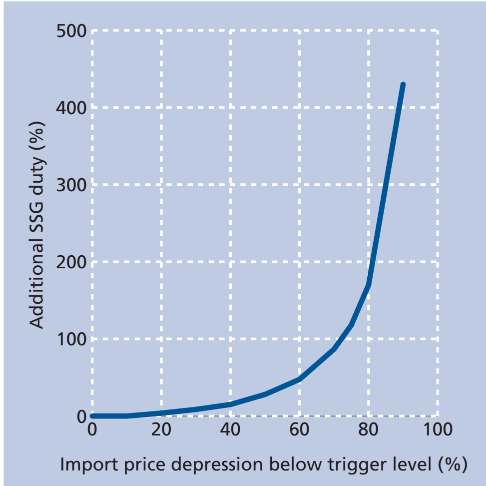
6 Specific procedures for calculating the tariff equivalent of all non-tariff measures.

Figure 17.1: Average bound, applied tariffs and tariff overhang by region



Source: Compiled by the author based on World Tariff Profiles 2010 (WTO).

Figure 17.2: Additional SSG duty depending on import price depression



Source: Konandreas (2008b).

Possible use of the Special Safeguard (SSG) Clause

Binding tariffs through the tariffication process, where tariffs serve as the only means to regulate imports, represented a threat to some countries that feared that the outcome would be a flood of imports that would hurt domestic production. This concern brought about Article 5 of the AoA that established provisions to invoke temporary duty increases, above the bound levels, on specified agricultural products. In order to invoke this safeguard, three conditions had to be met:

1. the product in question must have been subjected to the tariffication process;
2. the product must have been designated in the country Schedule as an "SSG product";
3. the criteria for either a price-based trigger or a volume-based trigger must have been met.

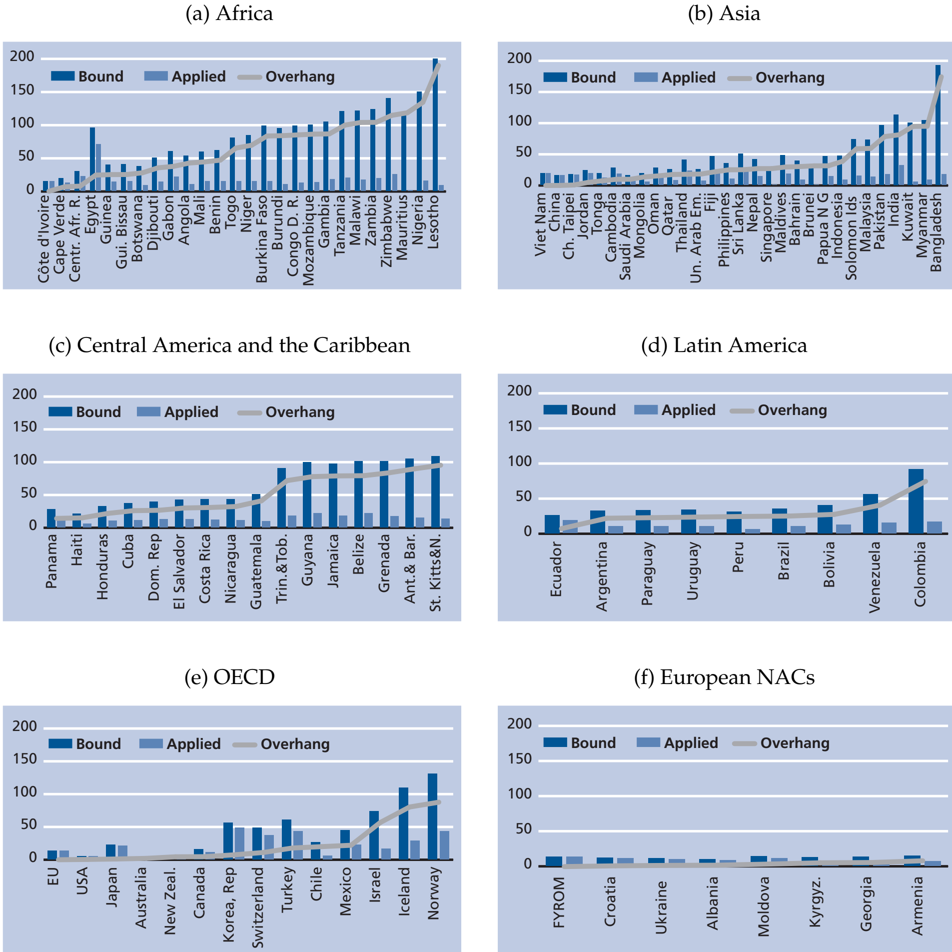
Thirty-six WTO members reserved the right to make use of the SSG provision, which could only be used for a limited number of products in each case. As the majority of developing countries did not tariffy, only a few of them had access to this provision.

Price-based SSG: The basic idea of the price-based SSG is that additional duties (over the bound rate) are allowed when import prices fall below an established trigger level. The trigger price is fixed (based on the 1986-88 reference price) while the remedy is variable (depending on how much actual import price drops below the reference price).

The formula for calculating the permitted level of the additional duty is somewhat complex and works like a variable levy - the greater the decline in the import price below the trigger level, the higher the duty - but it offsets only a part of the fall in the import price (see Figure 17.2).[7] This means that domestic prices are not entirely insulated from the effects of depressed world market prices.

[7] For example, with a trigger price $100/tonne and an import price $20 per tonne, the extra SSG duty would

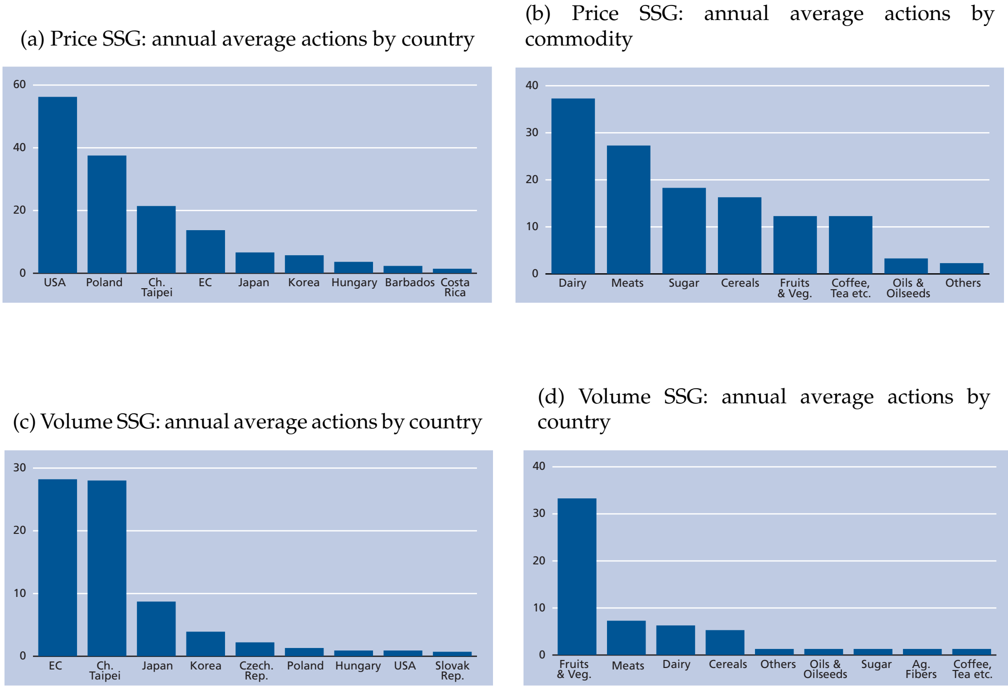
Figure 17.3: Agricultural tariff overhangs in different regions



Volume-based SSG: in the price-SSG, the basic idea of the volume-SSG is that additional duties (over the bound rate) are allowed when there is a surge in imports relative to an established trigger level of imports. Unlike in the price-SSG, here the trigger volume level of imports is variable and the remedy is fixed. The trigger level is higher (and the probability of using the trigger is less): the greater the three-year average level of imports, the lower the share of imports in domestic consumption, and the faster the growth in domestic consumption (Sharma, 2000b).

amount to 170 percent ($34 per tonne), which implies a domestic price of $54 per tonne (20+34). Even with that large extra duty, the domestic price is still 44 percent below the trigger level. Of course, the SSG extra duty comes into effect after the bound tariff is applied. Assuming a bound tariff of 100 percent for the commodity in question, then the SSG extra duty on top of the bound tariff would bring the domestic price to USD74 per tonne (20+20+34). In order for the domestic price to remain at the trigger level of $100 per tonne, a bound tariff of 230 percent would have been required.

Figure 17.4: Experience in the use of the price and volume SSG: 1995-2006



Source: Konandreas (2008b).

The maximum additional duty permitted cannot exceed 30 percent of the normal level of duty in effect during the year in which the volume-SSG is invoked. Also, the additional duty may not be levied beyond the end of the year in which it has been imposed, and it cannot be applied to imports taking place within tariff quotas.

Using the SSG: Overall, countries have made limited use of the SSG, but where it has been used it is highly concentrated to a handful of countries and commodities.

Four Members of the WTO accounted for 87 percent of all price-SSG actions during the period 1995-06, while four WTO Members accounted for 93 percent of all volume-SSG actions during the same period. In terms of the commodities acted upon, again four commodities accounted for 77 percent of all price-SSG actions and 92 percent of all volume-SSG actions during the same period. As expected, the great majority of countries that resorted to the SSG were developed countries because they had access to this instrument, having used the tariffication process in converting non-tariff barriers to ordinary tariffs, as discussed above. In addition, the majority of products acted upon concerned temperate-zone products.

Resorting to the general GATT safeguards

In addition to the SSG which, as noted, has limited applicability for the majority of developing countries, there are several generally applicable GATT safeguards. These include: anti-dumping, countervailing duties and emergency safeguards.

Anti-dumping (AD): Dumping is defined in general terms as the sale by a private firm of an exported product in a foreign market at a price below that at which the same product is usually sold in its home market. The basic GATT provision dealing with anti-dumping (AD) is Article VI of GATT 1994 on Anti-Dumping and Countervailing Duties. The Uruguay Round Agreement on Implementation of Article VI of GATT 1994 (commonly known as the "AD Agreement") further elaborates the basic principles set forth in Article VI and provides details regarding the investigation, determination and application of the AD duties.

To apply an AD duty, three conditions must be met:

1. a determination that dumping has occurred (including an estimate of the dumping margin, i.e. the difference in prices);
2. that a domestic industry is suffering from, or threatened with, material injury; and,
3. that the dumping is the cause of the injury.

The "injury test" is crucial, i.e. the dumped imports caused or threatened material injury to an established industry in the importing country. Other important rules are that the AD duty must not exceed the margin of dumping, and that the duty must be imposed on a non-discriminatory basis on imports from all sources found to be dumped and causing injury. Members with AD legislation are required to maintain independent "judicial, arbitral or administrative tribunals" to permit prompt review of administrative actions concerning final AD determination and to maintain the AD duties.

Countervailing (CV) duties: The thinking about countervailing duties is similar to that of AD, but while AD is aimed at unfair competitive activity by a private exporting firm, countervailing action is aimed at unfair practices resulting from government subsidies (both domestic and export subsidies). Otherwise, most of the procedural requirements are fairly similar. Two articles of the GATT deal with this subject: Article XVI on Subsidies (the source of the problem) and Article VI on Anti-Dumping and Countervailing Duties (the remedy). The Uruguay Round Agreement on Subsidies and Countervailing Measures (commonly known as the "CV Agreement") expands these articles substantially by providing a host of definitions (e.g. what constitutes a subsidy), describing the types of subsidies from the standpoint of CV actions (non-actionable, prohibited and actionable subsidies) and detailing the procedures and rules. Countervailing measures are a unilateral remedy taken by a Member, but they may only be applied after an investigation by that Member and a determination that the criteria set forth in the CV Agreement are satisfied. The substantive criteria require that a Member shall not impose a CV measure unless it determines that there are subsidized imports, injury to a domestic industry, and a causal link between the subsidized imports and the injury, as in the AD case.

Emergency safeguards The basic GATT provision dealing with emergency safeguards is Article XIX on Emergency Action on Imports of Particular Products. In practice, Article XIX was little used and much abused; it gave rise to such "grey area" measures as voluntary export restraints, orderly marketing agreements and similar other measures. The Uruguay Round Agreement on Safeguards (commonly known as the "SG Agreement") was negotiated "to re-establish multilateral control over safeguards and eliminate measures that escape such control".

The guiding principles of the SG Agreement are that safeguard measures pursuant to Article XIX: must be temporary; may be imposed only when imports are found to cause or threaten serious injury to a competing domestic industry; must (generally) be applied on an Most Favoured Nation (MFN) basis; be progressively liberalized while in effect; and, the Member imposing them must pay compensation to the Members whose trade is affected.

Emergency safeguards *differ from the AD and CV* measures in some important ways:

- First, they are not conditioned upon an "unfair" practice, i.e. there need not be dumping or subsidizing going on. Rather, they are predicated upon the argument that a suffering industry needs protection to adjust itself to the external shocks (e.g. import surges).
- A second feature of the provisions is that safeguard actions may be taken very rapidly if critical circumstances are deemed to exist (by contrast, provisional AD and CV duties can only be imposed after a preliminary investigation that provides an opportunity for all interested parties to comment and present evidence).
- A third distinguishing feature is that quantitative import controls can be used, whereas in the case of AD and CV measures only additional duties are permitted;
- Finally, another important difference is that, unlike AD and CV actions, compensation is required. The SG Agreement has laid down specific rules on "compensation" or "offsetting action" by maintaining "a substantially equivalent level of concessions".

For several developing countries, this last requirement for compensation may severely limit the scope for using emergency safeguards under the SG Agreement. Given the often small volume of their trade and its higher degree of concentration, they would not have much to offer in terms of trade concessions elsewhere.

Creating new defence mechanisms under the Doha Round

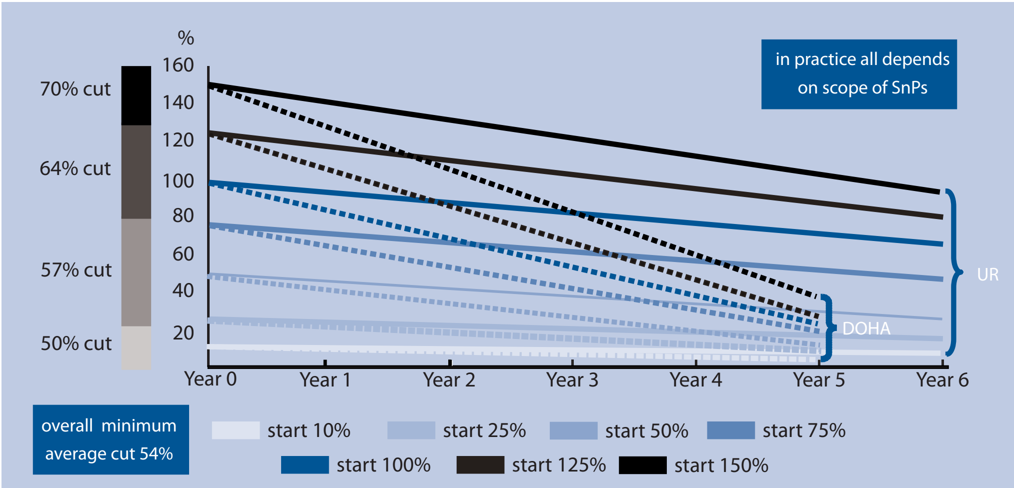
Proposals on border measures under the Doha Round aim to increase market access through a formula approach to tariff cuts while at the same time limiting its general application through exemptions. The general formula is based on a "tiered" approach which implies higher cuts for high tariffs. A different formula applies to developing than developed countries, which implies smaller overall cuts (see below). What is most important, however, are the special provisions envisaged on market access. These include Sensitive Products (SnPs) for both developed and developing countries and Special Products (SPs) and the Special Safeguard Mechanism (SSM) exclusively for developing countries.

Tariff cuts: The "tiered" formula approach in the Draft Modalities is a compromise reached after consideration of the very ambitious (such as the "Swiss") and less ambitious (such as UR) formulations. The main ingredient is that the cuts for higher tariffs would be higher and there is also clear differentiation on the cuts between developed and developing countries (Figure 17.5). Developed countries would have to meet a minimum average cut of 54 percent while developing countries a maximum average cut of 36 percent (these are overall averages, i.e. taking also into account the lesser cuts because of the application of SnPs and SPs provisions discussed below).

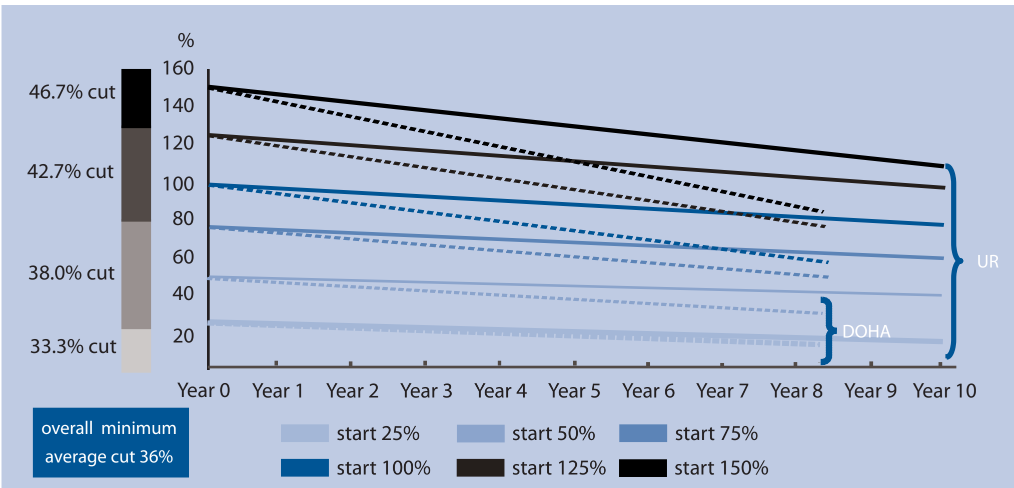
Sensitive Products (SnPs): Designating some products as sensitive in order to address non-trade concerns has been a longstanding demand of several WTO Members (mainly developed countries). Several issues remain unresolved in the Draft Modalities, including the number of SnPs (the latest proposal was up to 4 percent of tariff lines), the size of the additional quota for such products (the latest proposal was no less than four percent of domestic consumption, with some adjustments depending on current bound tariffs, and the extent to which the tariff cut for a sensitive product deviates from the general formula tariff cut).

Figure 17.5: Proposed tariff cuts under the "tiered" approach of the Doha Round

(a) Developed countries



(b) Developing countries



Source: Compiled by the author, based on WTO (2008).

Special Products (SPs): The driving force behind SPs has been the G33 group of developing countries. As in the case of SnPs, several issues remain unresolved, including: the total number of SPs (tariff lines at the six-digit HS level), those not subject to tariff cut, and the tariff reduction rate for the rest of the SPs.

In search for a compromise, at the July 2008 Mini-Ministerial meeting the WTO Director-General proposed 12 percent of tariff lines as the total number of SPs, of which 5 percent would have no tariff cut, with an overall average cut of 11 percent for all SPs. This has been incorporated in the December 2008 Draft Modalities text although a number of developing countries reserved their position regarding these numbers.

As in the case of SnPs, SPs are seen as a divisive element of market access because this flexibility could potentially cover many important agricultural products and markedly undermine the overall level of ambition on market access. On the other hand, the proponents of SPs view it as a key development instrument for ensuring food security, rural development and livelihood security.

Special Safeguard Mechanism (SSM): The SSM has been a thorny issue in the negotiations all along, and was allegedly the cause of the collapse of the WTO negotiations in July 2008. There were sharp differences in views on the SSM, *inter alia*, its product coverage, setting the threshold level for triggering volume-based SSM and setting the level of remedy.

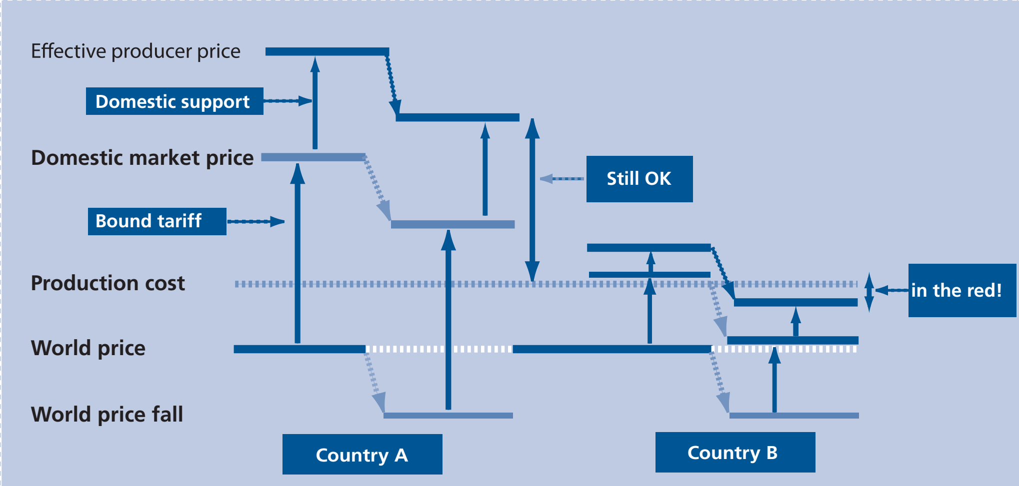
Concerning product coverage, the December 2008 Draft Modalities text states that the SSM shall have no *a priori* product limitations as to its availability, i.e. it can be invoked for all tariff lines in principle. The volume-based SSM shall be applied on the basis of a rolling average of imports in the preceding three-year period ("base imports"), with additional duty being triggered when the volume of imports during any year exceeds 110 percent of the base imports. The maximum additional duty that may be imposed on applied tariffs shall not exceed 50 percent of the current bound tariff (or 50 percentage points, whichever is higher) applicable when the volume of imports exceeds 135 percent of base imports.

Regarding the additional duty, the major difference all along was on whether the total duty (already applied plus SSM duties) could exceed pre-Doha bound tariff levels. On this issue the December 2008 Draft Modalities text states that SSM additional duty (whether price or volume related) are subject to the limitation that the pre-Doha bound tariff is respected as the upper limit and shall prevail as such. However, for LDCs this limitation is relaxed so that they may breach a pre-Doha bound tariff, provided that the maximum increase over a pre-Doha bound tariff does not exceed 40 *ad valorem* percentage points or 40 percent of the current bound tariff, whichever is higher.

Unfortunately, the original rationale of introducing the SSM under the Doha Round has been somewhat lost in the process of protracted negotiations. The SSM was supposed to be a means to provide temporary protection to those commodities threatened by short-term external shocks but which are otherwise competitive under normal conditions. Implicit in the need for this instrument is the notion that other means of protection are not available or practicable, i.e. countries had a small margin between an already applied tariff and the bound level and limited means to provide compensatory domestic support to farmers.

This is demonstrated in Figure 17.6, where two countries are contrasted: country A, with a high bound tariff and ability to support farmers through various forms of domestic measures, and country B which has a low bound tariff and limited means to provide domestic support. When the world market is at its average level, farmers' earnings are above cost of production in both countries. However, in a situation of substantial drop in the world market price, farmers in country B would be unable to remain in business. It is clear that the basic parameters of a rational and effective SSM are the level of bound tariffs (or better yet the difference between bound and applied rates, reflecting the remaining flexibility in raising tariffs) and the ability to compensate farmers through resource transfers.

Figure 17.6: Need for the SSM: low bound tariffs and limited capacity for domestic support



Source: Konandreas (2008b).

Domestic support

Ample flexibility under existing disciplines

The basic rationale for disciplining domestic support under the AoA was the fact that such support has been the main source of trade distortions. It was recognized that unless production is contained, the effect of border measures would not be effective in practice. However, it was also recognized that not all domestic support is necessarily bad. Hence, the basic approach in the AoA was to discipline only support that distorts production and trade (the traffic lights approach or the different colour "boxes"). The first step was to define what was permissible and not subject to reduction commitments. By implication, the rest had to be disciplined.

All countries may support domestic producers through "Green Box" measures, that is with policies considered to have no, or minimal, trade-distorting effects or effects on production and trade. These include, *inter alia*, general services to agriculture such as research, pest and disease control, as well as direct payments to producers, such as de-coupled income support, income insurance and safety-net programmes. Also included in the "Green Box" are food security stocks and domestic food aid programmes (discussed below).

Developing countries are also exempted from reduction commitments for a special category of production support policies, namely: generally available investment subsidies; agricultural input subsidies generally available to low-income or resource poor producers; and support to producers to encourage diversification from the growing of illicit narcotic crops (Article 6.2).

The "Blue Box" exempts support provided to farmers under production-limiting policies as an incentive to reduce production. Policies are placed in this category when they are accompanied by a commitment requiring farmers to limit production (to 85 percent of the base period level).

Measures that are neither Green, Special and Differential Treatment (SDT) nor Blue, are "Amber" (production and trade distorting) and are subject to reduction commitments. Typical policies under this category include:

- Product specific support (PSS), which typically includes state procurement at guaranteed administered prices for specific crops in excess of parity levels.
- Non-product specific support (NPSS), which typically includes subsidies for credit and inputs such as fertilizers, irrigation, or seeds, and aims to reduce the cost of production but does not explicitly target specific crops.

Both types of support are disciplined by the Aggregate Measurement of Support (AMS) ceiling levels, i.e. production and trade distorting support that countries have claimed in their schedules for the base period. Excluded from reduction commitments are PSS and NPSS that are less than the *de minimis* level (5 percent of the farm-gate value of production for developed countries and 10 percent for developing countries). Stockholding is also an option used by countries to support domestic producers in periods of depressed prices as well as to defend against high prices in years of short supplies. The related AoA provisions on stockholding are discussed in the following section.

Re-instrumentation of support under the Doha Round

In general, the proposals for reducing domestic support under the Doha Round continue to provide considerable flexibility for developing countries to support their farmers (Figure 17.7). At the same time the focus of further reform is on the large subsidizing countries that would have to undertake substantial reduction commitments in all forms of non-exempt domestic support. Several Organisation for Economic Co-operation and Development (OECD) countries legitimatized production and trade distorting support under the Uruguay Round and, moreover, have the ability (through government funding) to continue making use of such measures. The architecture of the AoA, in terms of its specific instrumentation, technically allowed plenty of room for these countries to meet their legal obligations, while actually pursuing similar distorting policies as before.[8] Several loopholes in this area would be closed under the Doha provisions.

Using existing flexibility by food-insecure developing countries

Do the AoA disciplines on domestic support pose a problem for developing countries? In general, the answer is no. Aside from some specific instances, the AoA disciplines are not presently constraining developing countries.[9] But why is this the case? There are two possible reasons: either their commitments are not too stringent, or actual support to agriculture is too low. By and large, the answer is the latter; actual support of agriculture in food insecure developing countries is desperately low.[10]

Historically, while countries have tended to tax agriculture in their early stages of economic development, successful take-off to sustained agricultural growth was achieved through a judicious mix of subsidies, pricing policies and border measures, as well as through other institutional and infra-structural support measures. This policy mix changes over time, depending on the stages of economic development of each country. In terms of specific

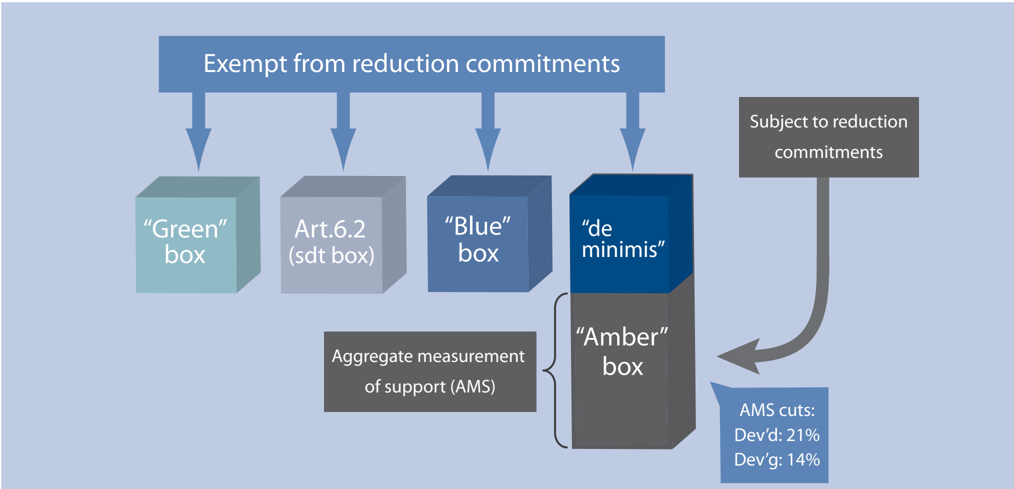
8 Some OECD countries exploited the loopholes of the AoA, and although they implemented the letter of their commitments, they did not always respect them in spirit. For example, domestic support reduction commitments were met, but support was shifted from the disciplined to the non-disciplined categories. Thus, overall support in OECD has not been reduced by much.

9 For example, see Sharma (2002).

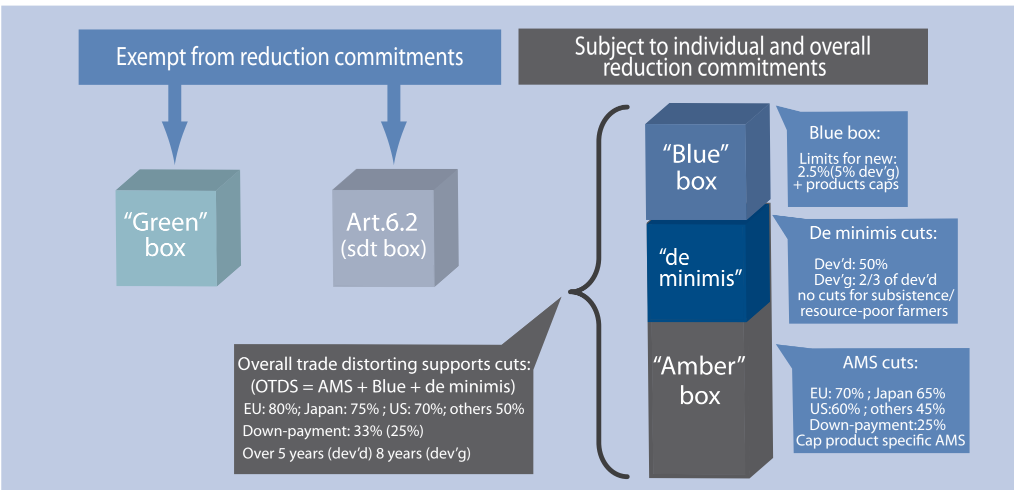
10 In the aggregate, developing countries as a whole account for less than 10 percent of agricultural subsidies, and these are basically accounted for by the better-off among them. In many instances farmers in poor countries are taxed instead of subsidized. In fact, in many developing countries, agriculture was taxed directly and indirectly in the past, as documented in Krueger et al. (1988).

Figure 17.7: Domestic support under Uruguay Round and proposals under the Doha Round

(a) Uruguay Round



(b) Doha Round



Source: Compiled by the author, based on WTO (2008).

measures pursued, after the early stage of infrastructural support to the sector, "coupled" rather than "decoupled" policies have been most effective in rapidly raising agricultural productivity and production.

For example, it has been amply substantiated by OECD analysis that input subsidies are the most production/trade distorting policies (even more so than product-specific output support policies, see Tangermann, 2005). It is obvious, therefore, that if curtailing output can best be achieved by suppressing these most distorting production and trade policies, the same policies need to be encouraged when the imperative is to increase output, which is the case in many food-insecure developing countries.

It follows that predominantly agrarian food-insecure developing countries should not only be exempted from reduction commitments under the AoA, but also encouraged and assisted in increasing support to agriculture. Moreover, unlike agriculturally developed countries that increasingly favour de-coupled “Green Box” policies, increased support for agriculture in food-insecure developing countries may initially have to come in the form of coupled support, in particular as “smart” input subsidies to achieve rapid increases in output of basic foodstuffs. There is also another important consideration that makes input subsidies a superior policy in food-insecure developing countries. In countries where a large part of the population spends most of its income on food, an input subsidy does not penalize poor consumers (which is the case in an output support policy) while it provides an incentive to farmers (by reducing production costs).

There are certain concrete implications of the above for the negotiations. On the defensive side, even though current subsidies in food-insecure developing countries hardly get close to even the 10 percent de minimis levels allowed under the AoA (separately for product-specific and non-product specific support), this legal cover for trade-distorting support should be maintained. This is all the more important considering that these countries hardly have any other “entitlements” to production/trade distorting support under the AMS, which is largely the prerogative of developed countries.

Another provision in the existing AoA that has proven very useful for food-insecure developing countries is the SDT clause of Article 6.2. This is well-suited to food-insecure developing countries where a large part of the farming population is resource-poor.

However, because domestic support costs money that many developing countries do not have, tariffs are their option of choice. FAO analysis has shown that tariffs in developing countries play a role in domestic market stability and for affording some protection to domestic producers in years of low world prices (Sharma, 2002). For this reason, food-insecure developing countries should preserve some of the flexibility they presently have in the form of high bound tariffs to defend against external volatility, partly emanating from policies in OECD countries, the reform of which is likely to be slow. Those developing countries that have little room in terms of high bound tariffs, may seek more generous treatment under the special provisions of SPs and the SSM. However, to be effective and transparent these provisions would need to be designed not as blunt, across the board instruments, but in relation to the problems they are meant to address, as was suggested above in regard to the SSM.

Overall, it may be said that the WTO disciplines, both border and domestic support measures, allow most developing countries considerable flexibility in defending against situations where domestic producers are threatened by depressed world prices. Often however, they are constrained by how much use they can make of the policy space they have because of food security and resource constraints.

WTO rules to defend against spikes in world prices

Besides the downside risk owing to depressed world market prices, there is also the case of upside risk when prices soar, as seen in 2007-08 as well as during the current 2010-11 marketing year. During such years countries usually put in place policies to support consumers by lowering import tariffs to make foodstuffs more affordable in the domestic

Table 17.1: World market prices of cereals and vegetable oils (2006 to 2008)

				% rise in prices		
				In 2007	In 2008	In 2008
	World market price (US$/t)			rel. to	rel. to	rel. to
Food	2006	2007	2008 [1]	2006	2007	2006
Rice	217	275	563	27	105	160
Wheat	200	266	407	33	53	104
Maize	122	164	230	34	40	88
Palm oil	478	780	1170	63	50	145
Soy oil	599	881	1 403	47	59	134
Simple average	323	473	755	46	59	134

Note: January-May 2008 for cereals and January-April 2008 for oils. Thai A1 variety of rice.
Source: Sharma & Konandreas (2008).

market, releasing supplies from stocks, increasing levels of food aid, targeting specific vulnerable groups, etc.

WTO rules are generally permissive as regards policies that are directed towards supporting consumers. This is understandable because such support, although market distorting (it generally leads to higher overall food consumption than otherwise), is nevertheless trade-enhancing and thus does not impinge on the export interests of trading partners. On the other hand, the lack of tight disciplines in this area reveals the asymmetry of the WTO rules as regards the interests of exporting and importing countries. In general, any policy that is trade enhancing (i.e. it leads to strengthening world prices) is hardly disciplined, even when it is detrimental to the food security concerns of other countries, unlike the tighter disciplines on trade-restricting policies, as we have seen above.

Border measures

Limited help from reducing applied tariffs

Table 17.1 shows the extent of price increases for cereals and vegetable oils during the last period of a spike in world prices. In 2007, prices rose by between 26 and 63 percent, and later by between 40 percent and 105 percent in early 2008. Compared with the 2006 levels, prices were higher in early 2008 by between 88 percent and 160 percent.

Lowering or eliminating import tariffs is the most common measure governments take to stabilize domestic prices of imported goods when world market prices rise. Approximately half of the countries surveyed by FAO lowered or eliminated import tariffs on cereals when world market prices soared in 2006-08 (FAO, 2008). However, the scope of this policy response is limited. Applied tariffs on basic foodstuffs were already relatively low in 2006, in the range of 8 to 14 percent for the five basic foodstuffs listed in Table 17.1, or even less than 10 percent when peak tariffs for about ten countries are excluded from the list (Table 17.2).[11] For the three cereals, the average was 11 percent, but only 6 percent for Low-Income Food-Deficit Countries (LIFDCs) when some peak cases are excluded.

11 This is owing to political economy considerations for affordable food, as well as loan conditionalities in some countries.

Table 17.2: Simple average tariffs on basic foodstuffs for LIFDCs in 2006 (percent)

	Wheat	Rice	Maize	Soy oil	Palm oil
LIFDCs (61 countries)	8	13	12	12	14
LIFDCs (excluding 10 countries of high tariff rates)	4	8	6	9	9

Note: For 14 countries, tariff rates are for 2005.
Source: Sharma & Konandreas (2008).

The point being made here is that most food-insecure developing countries did not have high enough applied tariffs in 2006 to be able to use this option to stabilize domestic prices in 2007, let alone in 2008. The level of the tariff reduction that would have been required in, say, 2007 or 2008, when world prices increased significantly, to stabilize domestic prices at the level of 2006 would have been much larger than the applied tariffs (10 percent or so) prevailing in 2006. Even reducing applied tariffs to zero would have counterbalanced only a part of the price rise of 2007, and not at all during the early months of 2008 when prices soared to even higher levels, unless countries resorted to import subsidization (i.e. negative tariffs), which most of them could not afford.[12]

The imprudence of export prohibitions, restrictions and export taxation

While import subsidization is a prohibitively expensive policy for importing countries to stabilize domestic food prices, export taxation and prohibition is fiscally advantageous and politically attractive for exporting countries to pursue in the face of high world prices that threaten their food security. In fact, when faced with soaring food prices in 2006-08, several countries took measures to limit the export of basic foodstuffs, including through taxation and/or outright export bans. Approximately one-quarter of the countries surveyed by FAO resorted to such measures (FAO, 2008). The potential effects of export restrictions on third countries, especially net food-importing countries, can be serious. While the rise in domestic prices may be contained somewhat in the countries imposing export restrictions, the burden is carried by other countries and world prices rise further, turning a surmountable situation into a potentially full-blown crisis.

What is the role of WTO rules in this respect? In the AoA, the relevant provisions are covered under Article 12 (Disciplines on Export Prohibition and Restrictions).[13] However, paragraph 1 of Article 12 makes an important qualification in its application by linking it

12 Assuming that the domestic price (Pd) for any given year is determined as $Pd = Pw * (1+t)$, where Pw is world price and t is the initial applied tariff, then the tariff reduction that would leave the domestic price unchanged can be calculated from the following equation: $Pw*(1+t) = (Pw+\triangle Pw)*(1+t+\triangle t)$, by solving for $\triangle t$. If the absolute value of $\triangle t$ is greater than t, then an import subsidy equal to the difference would be required to counterbalance an increase in world price by $\triangle Pw$.

13 The relevant paragraphs of Article 12 of the AoA are as follows:
1. Where any Member institutes any new export prohibition or restriction on foodstuffs in accordance with paragraph 2(a) of Article XI of GATT 1994, the Member shall observe the following provisions:
(a) the Member instituting the export prohibition or restriction shall give due consideration to the effects of such prohibition or restriction on importing Members' food security;
(b) before any Member institutes an export prohibition or restriction, it shall give notice in writing, as far in advance as practicable, to the Committee on Agriculture comprising such information as the nature and the duration of such measure, and shall consult, upon request, with any other Member having a substantial

("in accordance with") to paragraph 2(a) of GATT Article XI according to which "export prohibitions or restrictions temporarily applied to prevent or relieve critical shortages of foodstuffs or other products essential to the exporting contracting party" are permitted. Neither "critical shortage" nor "temporary" is defined. Critical shortage is presumably at the discretion of the country imposing the export restriction, and temporary could mean months or even a year or more.

Paragraph 2 of Article 12 exempts developing country Members from the general rule in paragraph 1, unless they are "net food exporters" of the specific foodstuff in question. Many developing countries are now significant exporters of basic foodstuffs and it would appear that they would also have to adhere to the general provisions of paragraph 1, however, in practical terms this may mean very little. There is no list of net food-exporting developing countries at the WTO (for specific products) nor criteria to define a net food-exporter (e.g. which foodstuffs to be covered and over what base period). While the converse list of "net food-importing developing countries" exists as a WTO category (based on self-designation and subject to verification of the relevant data), it has been constructed for the purpose of the Marrakesh Decision (see below) and nowhere it is implied that a country not belonging in this latter category automatically belongs to the net food-exporter category.

Thus, essentially, current WTO rules allow the use of export restrictions when countries face domestic shortage. Export taxation was never disallowed, and this tax could be prohibitively high because, unlike import tariffs, it is not bound anywhere. If requested, the two obligations called for in Article 12 of the AoA, i.e. giving due consideration to the effects of such prohibition or restriction on importing Members' food security and providing advance notification and consultation, are useful to some extent for exerting some moral restraint on the exporter, but they may not actually mean anything in concrete terms.

It is not clear to what extent any of the WTO Members that resorted to export prohibitions or restrictions during the recent past have given due consideration to others' food security needs. There was no formal consultation in the WTO Committee on Agriculture (CoA) on the scope and duration of the measures that were put in place or on the possible adverse effects for other Members who may have had a substantial interest as importers of food commodities subject to such export prohibitions or restrictions.

The asymmetry in WTO application of disciplines to imports and exports has been pointed out during the current negotiations on agriculture, and several countries have proposed stronger rules in this area. Japan's negotiating proposal was the most comprehensive (WTO, 2000). It focused on rules and disciplines on exports and on redressing the imbalance between rules and disciplines applied to agricultural exporting countries and those applied to importing countries. The reference to imbalance is to contrast the weak rules on exports compared with well-defined and binding rules on imports. In addition, Switzerland had called for eliminating all export restrictions on agricultural products and the binding at zero of all export tariffs (with flexibility for the less developed countries, LDCs). The Republic of Korea also proposed prohibiting exporting countries from imposing export restrictions and also prohibiting the use of export taxes. Several other proposals called for improved disciplines on export restrictions and on binding export taxes.

However, there is resistance on these issues from other WTO Members, and it is questionable whether stronger disciplines on export prohibitions, restrictions and export

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interest as an importer with respect to any matter related to the measure in question. The Member instituting such export prohibition or restriction shall provide, upon request, such a Member with necessary information.

2. The provisions of this Article shall not apply to any developing country Member, unless the measure is taken by a developing country Member which is a net-food exporter of the specific foodstuff concerned.

taxation can materialize under the Doha Round. Article 12 of the AoA will remain weak as long as there is a link to paragraph 2(a) of GATT Article XI. However, at the minimum, existing Article 12 should be strengthened in some important ways:

- First, an obligation to submit a notification to the WTO CoA prior to instituting any new export prohibition or restriction on foodstuffs. Such notifications should be supported by detailed data and analysis demonstrating the reasons for instituting such measures and how trading partners of that Member may be affected;
- Second, upon receipt of such notification to the WTO CoA, there should be an obligation to respect a mandatory consultation period (say of one month) with potentially affected countries, again prior to the export restriction being implemented; and
- Third, an obligation to spell out explicitly the duration of an eventual measure, stipulating a maximum period of its application (e.g. three months).

The current price spike in world food prices (2010-11), again partly related to export prohibitions by some key exporting countries, may provide additional incentives to fix some of the problems with export prohibitions and restrictions along the lines suggested above, within the ongoing Doha Round negotiations.[14] Beyond the food security concerns of net food-importing countries, weak WTO rules in this area are also detrimental to the multilateral trading system itself. It raises doubts about the world market being a reliable source of food supplies and puts under question the credibility and impartiality of efforts to reform world agricultural trade (Konandreas, 2008a).

Stockholding and domestic food aid

Stockholding operations, with their objective of providing minimum support to farmers while also helping consumers through food distribution schemes, have been a very common response to domestic and international market instability in the past. While such schemes often proved costly and not always effective, and many countries have moved away from such interventions, their appeal is clear from the point of view of vulnerable countries as they offer some degree of protection against domestic and external shocks.

What do the WTO rules say about such measures? The relevant provisions in the AoA are under paragraph 3 and paragraph 4 of Annex 2 of the AoA (the "Green Box")

As regards public stockholding, the general provisions in paragraph 3 of the “Green Box” (“public stockholding for food security purposes”) stipulate that: the accumulation and holding of such stocks should form an integral part of a food security programme identified in national legislation; the volume and accumulation of such stocks shall correspond to predetermined targets related solely to food security; and the process of stock accumulation and release shall be financially transparent, including being carried out at current market prices. Specifically for developing countries, footnote 5 of paragraph 3 relaxes this general provision, whereby public stocks for food security purposes may be acquired and released at administered prices, provided that the difference between the acquisition price and the external reference price is accounted for in the AMS.

As regards subsidized distribution, the general provisions in paragraph 4 of the “Green Box” (“domestic food aid”) stipulate that eligibility to receive food aid shall be subject to

[14] Renewed calls for strong disciplines on export restrictions are being made following temporarily halting of exports of wheat and other grains by the Russian Federation and Ukraine in the latter part of 2010 in order to protect supplies for their own people. For example, Caroline Spelman, UK Environment Minister, argued that no country should be allowed to interfere with the global food commodity market (“Halting food exports should be illegal”, The Guardian, January 5, 2011). See also Diaaz-Bonilla & Ron (2010).

clearly-defined criteria related to nutritional objectives; that such aid shall be in the form of direct provision of food to those concerned or the provision of means to allow eligible recipients to buy food either at market or at subsidized prices; and that the financing and administration of the aid shall be transparent, including food purchases by the government made at current market prices. Specifically for developing countries, the provision of foodstuffs at subsidized prices with the objective of meeting food requirements of urban and rural poor in these countries on a regular basis at reasonable prices should be considered to be in conformity with the provisions of this paragraph.

In the Draft Modalities, the conditions regarding the acquisition of stocks for food security purposes, including for use in domestic food aid programmes, are further relaxed (WTO, 2008). The Draft Modalities text excludes from the AoA disciplines the acquisition of foodstuffs at subsidized prices with the objective of "supporting low-income or resource-poor producers", "fighting hunger and rural poverty" and "in relation to lowering prices to more reasonable levels". These additions provide more flexibility to the existing provisions of the AoA for developing countries, which stipulate that only the provision of food can be at subsidized prices but not its acquisition.

A number of developing countries, especially in Africa, have stockholding policies for price stabilization or targeted food distribution. These programmes are not known to have been constrained by the current AoA disciplines (AMS and/or *de minimis* limits). This may, however, change in the future in response to recent experiences of soaring food prices, with more countries putting in place such schemes. In this connection, the additional flexibility provided in the new AoA rules is a positive development, even with the requirement that the acquisition of stocks must be tied to the objective of supporting low-income or resource-poor producers, a situation generally prevalent in food-insecure developing countries. Therefore, for all practical purposes, public stockholding and related domestic subsidized distribution programmes in food-insecure developing countries are WTO-compatible for as long as they form an integral part of a food security programme and are targeted to those in need, both of which are laudable objectives.

State Trading Enterprises

Closely related to public policy for food security is the role played by State Trading Enterprises (STEs), an issue also under negotiation in the Doha Round. The main concern about STEs all along has been the risk of their operations undermining the other disciplines on export competition (export subsidies, food aid and export credits). Thus the Draft Modalities text includes provisions for the elimination of, in parallel and in proportion to the other provisions on export competition, all forms of subsidization of such STEs.

In general, these concerns apply more to exporting STEs and not to importing STEs for basic foodstuffs, the latter being mostly the case for developing counties. The draft text also contains SDT provisions under which STEs in developing country Members would not be constrained by the envisaged disciplines, to the extent that their state trading activities have social objectives (such as domestic price stability, food security and rural development) and/or also to the extent that their STEs are too small to have an effect on world markets and are not otherwise inconsistent with other WTO rules. These SDT provisions would in principle allow developing countries to maintain their STEs, although their contribution to alleviating the adverse effects of food price volatility would depend on how effectively they pursue their stated social objectives.

WTO provisions on behalf of third countries

In addition to the multilateral rules on production and trade policy and related commitments largely reflecting national interests of domestic producers and consumers discussed above, there are also other commitments made individually or collectively by WTO Members that have important implications for other countries in their efforts to deal with price volatility. These include particularly export financing support, international food aid and possible assistance under the Marrakesh Decision of the Uruguay Round.[15]

Export financing support

Under this heading are provisions on export credits, export credit guarantees or insurance programmes. There are no rules regarding these instruments in the existing AoA, but WTO Members had agreed to work towards developing relevant disciplines (Article 10.2 of the AoA). By and large, negotiations under the Doha Round on these issues focused not so much on how related provisions can be made more effective in helping food-insecure countries in financing needed food imports, but on preventing circumvention of export subsidy commitments.[16]

In the Draft Modalities text, measures under export financing support (comprising export credits, export credit guarantees or insurance programmes) are described as follows:

1. Direct financing support, comprising direct credits/financing, refinancing and interest rate support;
2. Risk cover, comprising export credit insurance or reinsurance and export credit guarantees;
3. Government-to-government credit agreements covering the imports of agricultural products exclusively from the creditor country under which some or all of the risk is undertaken by the government of the exporting country; and,
4. Any other form of governmental export credit support, direct or indirect, including deferred invoicing and foreign exchange risk hedging.

The provisions to be agreed shall apply to all "export financing entities" that are either government agencies or private entities with government participation in any form, or that receive government support or provide insurance or guarantees.

There are two elements of the export financing support schemes that would be disciplined: *maximum repayment term* and *premium rates*. For the former, the general rule is to limit the maximum repayment term for export financing support to no more than 180 days. For the latter, the fundamental principle proposed is that export credit guarantees, insurance and reinsurance programmes, and other risk-cover programmes shall be *self-financing* by the interest rate charged.[17]

Beyond these general provisions, there also arose a need to address the concerns of the LDCs and the net food-importing developing countries (NFIDCs) in view of the Marrakesh Decision where Ministers had agreed to "ensure that any agreement relating to agricultural export credits makes appropriate provision for differential treatment in favour of LDCs and

[15] "Decision on Measures Concerning the Possible Negative Effects of the Reform Programme on Least-Developed and Net Food-Importing Developing Countries".

[16] This is understandable, considering the principle agreed by WTO Members to undertake commitments in all areas of direct and indirect export subsidization, including export credits and food aid, in parallel with the elimination of export subsidies.

[17] The relevant text reads as follows: "Where premium rates charged under a programme are inadequate to cover the operating costs and losses of that programme over a previous 4-year rolling period, this shall, in and of itself, be sufficient to determine that the programme is not self-financing."

NFIDCs." Historically, both the LDCs and NFIDCs have not accessed much of the global total of agricultural export credits, mainly reflecting lack of access and not a lack of need for this import financing mechanism. One important SDT provision in the Draft Modalities concerning LDCs and NFIDCs as beneficiaries of export financing is the repayment period that will be between 360 and 540 days for the acquisition of basic foodstuffs.[18] In addition, should an LDC or NFIDC face "very exceptional difficulties"[19] which preclude financing normal levels of commercial imports of basic foodstuffs and/or in accessing loans granted by multilateral and/or regional financial institutions, the repayment term can be extended (beyond 540 days) to meet humanitarian needs for basic foodstuffs. This is, however, subject to notification and review.

It may be noted that there is no SDT provision for all developing countries as beneficiaries of export financing, only for LDCs and NFIDCs. On the other hand, there is an SDT provision applicable to all developing countries as providers of export financing support. They will have a phase-in period of four years after the first day of the implementation period to fully implement the maximum repayment term of 180 days (with 360 days for export financing arrangements concluded in years 1 and 2 and 270 days in year 3). This could prove useful in broadening the possibilities of developing countries in sourcing imports of basic foodstuffs under favourable terms, including during periods of distress in view of high world food prices.

International food aid

The origins of food aid date back to the early 1950s, when the accumulation of food surpluses (mostly cereals) in North America gave rise to the idea that these surpluses could be "disposed of" to help countries experiencing food shortages. This led to the establishment of the FAO Principles of Surplus Disposal,[20] administered by the FAO Sub-Committee on Surplus Disposal (CSSD) (see FAO 2001a).

The CSSD, together with the Food Aid Convention (FAC), which broadened the donor base of food aid and established criteria for its provision and use, were the key institutional bodies governing food aid and were explicitly recognized as such in the Uruguay Round AoA (see below). Food aid thus became part of the WTO rules governing trade in agricultural products. While this may have implied better adherence to CSSD and FAC guiding principles (as they were now part of the binding WTO system), it also brought with it certain inertia to change, in the sense that food aid rules could no longer move independently from the rest of the rules governing agriculture. Indeed, as for the whole package of issues on agriculture being negotiated under the Doha Round, there has been an impasse in the arrangements governing food aid, although it is widely recognized that the situation on the ground necessitates important changes in the provision and use of food aid.[21]

[18] It should be noted that this SDT for LDCs and NFIDCs concerns only the acquisition of basic foodstuffs and not all other food and agricultural commodities.

[19] Note also that the term "very exceptional difficulties" is not defined, which could be a divisive issue during implementation.

[20] The "Principles" is a code of international conduct adopted by the FAO Council in 1954, encouraging the constructive use of surplus agricultural commodities and at the same time safeguarding the interest of commercial exporters and local producers.

[21] This includes in particular the growing requirements of protracted emergency situations and the need for flexibility of food-related assistance to better respond to these needs. Emergency food aid now constitutes nearly four-fifths of the total food aid. See Konandreas (2010).

Existing provisions

The existing disciplines on food aid under the AoA are contained in paragraph 4 of Article 10 on the Prevention of Circumvention of Export Subsidy Commitments. It is clear that the incorporation of food aid disciplines under this article was meant to avoid abuse of food aid, particularly in situations where it could be provided in terms and conditions that would circumvent export subsidy commitments.[22]

In essence, paragraph (a) of Article 10.4 calls upon donors to ensure that "the provision of international food aid is not tied directly or indirectly to commercial exports of agricultural products to recipient countries." How this is to be ensured is spelled out in paragraph (b) which states that "international food aid transactions, including bilateral food aid which is monetized, shall be carried out in accordance with the FAO "Principles of Surplus Disposal and Consultative Obligations", including, where appropriate, the system of Usual Marketing Requirements (UMRs)", while paragraph (c) stipulates that "such aid shall be provided to the extent possible in fully grant form or on terms no less concessional than those provided for in Article IV of the Food Aid Convention 1986."

While the tenor of the current disciplines appears restrictive, in practice they are mere guidelines rather than strictly binding rules that would constrain the provision of food aid in any way. This was one of the main reasons that the Doha Round negotiations on food aid have been intense and so inclined towards tightening the rules on food aid.

Over time there have been important improvements in the food aid system in terms of assessing more precisely the specific needs of recipient countries and responding to them with more flexibility as regards the resources needed and the complementary measures to be taken. However, the system is not yet free from its legacy dating back more than five decades when the notion of "surplus disposal" was first introduced and when food aid policies were driven, by and large, by the supply availabilities in donor countries. Complete de-linking from donor surplus supplies has yet to be attained. As a consequence, food aid still remains highly variable and an uncertain resource, with commodity prices, stock levels and shipping costs playing a key role.

The precarious and unpredictable nature of food aid is more evident during periods of high price volatility. As food prices rise, food aid declines (Figure 17.8).[23] This inverse relationship is anticipated as food aid is expressed in monetary terms in donor national budgets. Hence, a given amount of funds translates to less quantity under a situation of rising prices. Overall, whether in normal years or years of dear food, the role of food aid has declined considerably since the mid-1990s, although it remains a critical source of supply for some food-insecure countries.

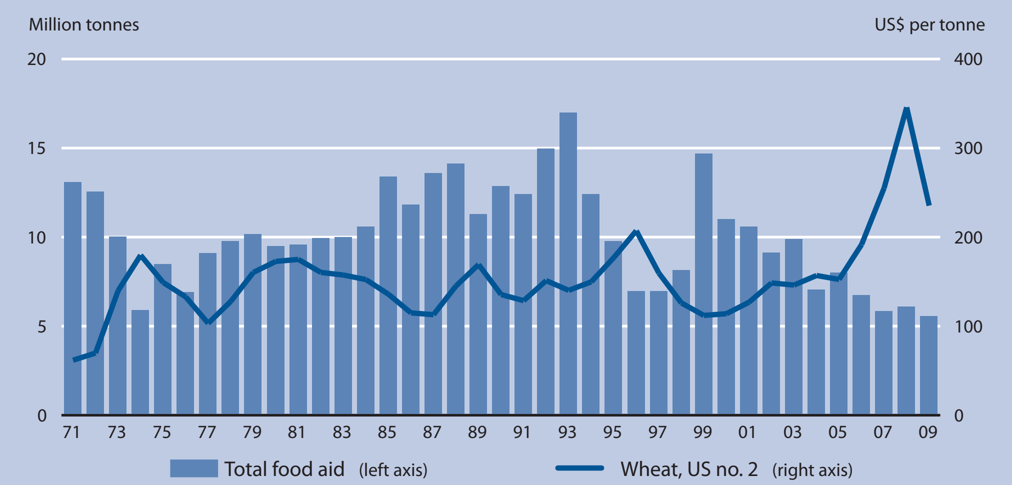
New disciplines under the Doha Round

As for the future, the rules that would govern food aid are those being negotiated under the Doha Round, as part of the new AoA. First, several "general disciplines" are proposed to be applicable to all food aid transactions, no matter what the intended use of food aid, in

[22] The other reference to food aid in the Uruguay Round agreements is in the Marrakesh "Decision on Measures Concerning the Possible Negative Effects of the Reform Programme on Least-Developed and Net Food-Importing Developing Countries". Food aid, together with export credits and food financing facilities, are the response measures envisaged under the Marrakesh Decision to help LDCs and NFIDCs facing short-term difficulties related to importing adequate foodstuffs on reasonable terms and conditions (more on the Marrakesh Decision below).

[23] The correlation coefficient between the volume of total food aid shipments and the world price of wheat (taken as a proxy of food prices in general) over the 1971-2009 period is -0.59.

Figure 17.8: Food aid declines as world prices rise



Source: Based on FAO and WFP data.

particular: needs-driven; in fully grant form; not tied directly or indirectly to commercial exports of agricultural or other goods and services; not linked to market development objectives; and, not re-exported (except when absolutely required to meet an emergency situation in other countries).[24]

While all food aid transactions should conform to the general disciplines above, further rules distinguish between emergency and non-emergency situations. Food aid in emergency situations (whether cash or in-kind) is placed under a "Safe Box" (akin to "Green Box" in domestic support disciplines) in the sense that such transactions will not be contested. However, food aid in non-emergency situations, i.e. outside the "Safe Box", would be under stricter disciplines, in particular: based on a needs assessment; provided to redress chronic hunger and malnutrition; targeted to identified food insecure groups; and, its provision would minimize commercial displacement.

The most contentious part of the new food aid disciplines is the monetization of in-kind food, whereby it may be permissible under well-defined and monitorable circumstances.

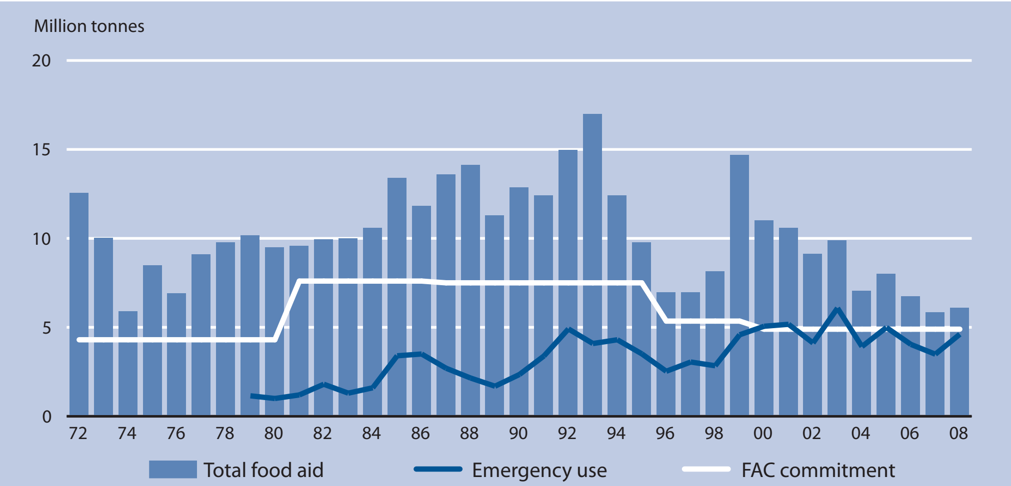
While the above provisions generally represent considerable progress within what is politically feasible, the Doha Round is still in suspense and nothing can be agreed independently from the rest of agriculture and non-agriculture issues. Meanwhile, the international community is anxious to see progress in food aid and to better respond to the changing food security situation on the ground.

Growing emergency needs and limited role of food aid in high price years

The first priority of food aid is responding to the rapid increase in humanitarian relief and crisis-related emergency situations. The number of emergency operations during the 2001-10 nearly doubled compared with the 1980s and the demand for emergency food aid has also

[24] Three additional "guidelines" are also stipulated as regards taking fully into account local market conditions: i) refrain from providing in-kind food aid where this would cause an adverse effect on local or regional production of the same or substitute products; ii) food aid providers encouraged to procure locally or regionally to the extent possible; and iii) make best efforts to move towards more cash-based food aid.

Figure 17.9: Total food aid, emergency use and FAC commitments



Source: Konandreas (2010).

doubled, standing on average at 4.55 million tonnes during the period 2001-08 compared with about half that amount in the 1980s. At the same time, following the WTO agreement in 1995, total food aid availability has declined considerably, in parallel with the aggregate minimum commitment under the FAC, which was adjusted downwards by over two million tonnes and now stands at some 4.895 million tonnes. As a result, emergencies absorbed nearly 80 percent of total food aid in 2008 compared with well below 20 percent up to 1990 (Figure 17.9).

Therefore, on average, there is only a small positive margin between aggregate minimum FAC commitments and aggregate emergency needs (an average of 345 000 tonnes during 2001-08). It follows that to the extent that all commitments under the FAC were for the exclusive use of emergency operations, these resources would just about suffice, although this average margin could not to be counted upon all the time. As shown in Figure 17.9, in at least three of the last eight years, emergency needs for food aid alone were above the aggregate minimum commitment under the FAC.

But there are other legitimate needs in addition to emergencies. Besides programme food aid, which is declining rapidly and enjoys little support for a variety of reasons, there are genuine needs of vulnerable groups in food-insecure developing countries, which averages 1.35 million tonnes during 2001-08. By and large these involve multi-year projects to address the needs of chronically food-insecure people, and there is very little room for reducing such resources without inflicting hardship to the dependent target populations.

It follows that, based on present FAC commitments and genuine emergency and project food aid needs, there is little flexibility to allow a permanent and inconsequential diversion of resources from FAC minimum commitments to address additional difficulties facing countries during periods of high price years. Moreover, it is during such years that commitments under the FAC are barely above the minimum, and also during such years that nutritional interventions become imperative as more people fall below the poverty line.

The conclusion is that under the present aggregate minimum commitment of the FAC, diverting food aid resources away from their prioritized use may seriously compromise the timely availability of resources for meeting pressing emergency needs as well as the needs of chronically food insecure populations. The present FAC offers little room for providing any relief to countries facing difficulties from high food prices. It follows that serious consideration should be given in the renegotiation of the FAC to raising its aggregate minimum commitment (see below).

The need for strengthening the Food Aid Convention

While the stalemate at the WTO has prevented the conclusion of the new FAC, expediting its renegotiation to better meet its objectives has been the focus of attention by the international community for some time. In connection with this, the FAO has put forward some concrete ideas for desirable amendments to the FAC, especially in order to better respond to growing emergency and other humanitarian needs. These proposals would have to take onboard, *inter alia*, the substantial progress that has been made so far under the Doha Round negotiations, as well as the realities on the ground concerning food aid needs and modalities for its provision. As an incremental process, with one instrument improving upon what has already been agreed by the other, the provisions of the new FAC would then have to be incorporated and "legalized" under the eventual Doha Round agreement.

The suggested specific improvements of the FAC include (Konandreas, 2010):

- Incorporating agricultural inputs into the FAC. This does not imply bringing into the FAC long-term assistance to developing countries in general, but small quantities of inputs that are part and parcel of the emergency response to crisis-affected countries in order to expedite their recovery and thus avoid a continuing dependence on outside food assistance.
- Raising the FAC minimum commitments. Adequate funding for the FAC in relation to the situation on the ground is not only defensible from the humanitarian point of view, but it makes good economic sense compared with the alternative of having to resort to ad hoc and expensive last minute emergency operations because of an inability to plan ahead.
- Broadening the FAC donor base. Together with raising the minimum commitments of existing Members, efforts should be made to broaden the FAC donor base by bringing new donors formally into the FAC.
- Earmarking and prioritizing FAC resources to emergency operations. Donations under the FAC should be earmarked exclusively for emergency operations and the needs of genuine nutrition intervention projects.
- Introducing flexibility in funding arrangements. The new FAC should allow more flexibility in annual donor contributions, through carry-forward and carryover, to give donors a degree of flexibility in inter-year shifting of contributions to better respond to variable needs.
- Ensuring compatibility with WTO rules. Certain provisions of the FAC need to be brought in line with existing rules and what may be eventually agreed under the Doha Round, including definition of eligible recipient countries and targeting food related assistance, especially to resource-poor farmers in developing countries.

The Marrakesh Decision and food financing facilities

The Marrakesh Decision was included in the Uruguay Round agreement because of the recognition that certain vulnerable countries that depend on the world market for a substantial part of their basic food needs may face additional difficulties in financing such foodstuffs as a result of higher prices from the implementation of the AoA.

Lack of progress in implementing the decision

Partly because of the near impossibility to establish a clear link between financing difficulties and the implementation of the AoA, there has been very little progress in implementing the

Decision, despite efforts the countries concerned have made over the years with support of international organizations. The Decision itself is not being re-negotiated in the Doha Round, but as discussed already, food aid and export credits are, which are two of the four mechanisms[25] for helping LDCs and NFIDCs under the Decision.

It is hardly disputed that many LDCs and NFIDCs have balance of payments difficulties even in normal times, and face additional short-term difficulties financing normal levels of commercial imports of basic foodstuffs in more difficult times, such as when food prices soar in the world markets. In the context of the Decision, FAO had undertaken a detailed analysis in 2002 of the difficulties for LDCs and NFIDCs in financing food imports (FAO, 2003). Among other things, the FAO analysis noted that unlike the past, food imports were now largely undertaken by private traders and this had not always helped financing food imports when needs surged. This is largely because the private sector - working in an environment of high risks, underdeveloped banking services and the extra collateral demand this entails - lacks finance and related guarantees which importing government agencies used to enjoy in the past.

As regards possible assistance from food financing facilities, the relevant paragraph of the Marrakesh Decision reads as follows: "Ministers recognize that as a result of the Uruguay Round certain developing countries may experience short-term difficulties in financing normal levels of commercial imports and that these countries may be eligible to draw on the resources of international financial institutions under existing facilities, or such facilities as may be established, in the context of adjustment programmes, in order to address such financing difficulties". In relation to "international financing institutions", the Decision explicitly mentions the IMF and the World Bank, and for this reason much attention has been drawn to related facilities maintained by these agencies.

Among the facilities, the one closest - both in spirit and content - to that envisaged in the Decision, and the one that has attracted the most attention in subsequent discussions is the IMF's Compensatory Financing Facility (CFF), which encompasses a cereal import bill component.[26]

IMF's CFF and the new exogenous shocks facility of 2005

The CFF was created in 1963, and the cereal import element was added in 1981 following increased volatility of food prices in the 1970s.[27] The CFF was further streamlined in 2000. Its main features since the streamlining have been as follows:

- the purpose of the CFF is to help members cope with *temporary* export shortfalls and high cereal import costs that create an overall balance-of-payments need. Commodity price shocks that do not create a temporary balance-of-payments need do not qualify for compensation;
- it is a non-concessional facility and there are access limits; and,
- as most borrowers usually have balance-of-payments problems that extend beyond the temporary shock, other Fund arrangements and conditionalities invariably apply to borrowing from the CFF.

There has been very little use of the cereal element of the CFF. In the period from January 1993 to September 1999, there were six purchases by four countries (Algeria, Bulgaria, Moldova

[25] The other two draw on food financing facilities and technical and financial assistance to improve their agricultural productivity and infrastructure.

[26] The World Bank also has several instruments for emergencies, like the Import Rehabilitation Loan and Emergency Recovery Credit/Loan, but these are not as closely linked to the issue of excess import bills as is the CFF.

[27] Relevant research at the time was partly influential in IMF's decision to extent the CFF to cover cereals (see Konandreas et al. 1978).

and South Africa). None of these countries, however, is an LDC or an NFIDC. Commentators had all along pointed to the limitations of the CFF in financing excess food import bills, for reasons noted above (balance of payments, need to take into account export earnings, conditionality, non-concessionary nature, etc.). The IMF's own evaluation of 2004 also reached similar conclusions (IMF, 2004).

In November 2005, the IMF established a new facility, the Exogenous Shocks Facility (ESF) within its Poverty Reduction and Growth Facility (PRGF) Trust. The ESF is designed to provide concessional financing to low-income countries that are experiencing exogenous shocks but do not have a PRGF arrangement in place (for those with a PRGF arrangement in place, the IMF can enhance its support for dealing with shocks by augmenting the resources available under that arrangement).

As of late 2007 no country had requested assistance under the ESF, despite the difficulties many were experiencing in financing food imports owing to the already high food prices at the time. In September 2008, IMF's Executive Board approved modifications to the ESF that provided for faster and higher access, made the facility easier to use, and enhanced its flexibility. These modifications took effect in November 2008 and based on the experience since then, the ESF has become a much more useful instrument for countries facing difficulties in financing food imports.

Immediately following the modifications introduced to the ESF, several countries sought and received assistance under this facility. Since December 2008, some 12 countries applied for and received loans.[28] In the aggregate, the loans approved for these 12 countries amounted to some USD 1.25 billion. Financing terms under the ESF are equivalent to a PRGF arrangement and are more concessional than under other IMF emergency lending facilities.[29] The ESF remains the IMF's main facility relevant for most LDCs and NFIDCs facing difficulties in financing food imports because of external price shocks.

Food Import Financing Facility (FIFF)

During the earlier years of the Uruguay Round implementation, some debate had taken place on the appropriateness of the CFF for the purpose of the Marrakesh Decision. Concluding, for the reasons noted above, that the CFF had major limitations in addressing "short-term difficulties" as foreseen by the Marrakesh Decision, a group of 16 LDCs and NFIDCs proposed in 2001 the creation of a new, dedicated financing facility (WTO, 2001).

The proposal (based on (FAO, 2001b) analysis) was to create a "revolving fund" from which LDCs and NFIDCs would borrow short-term loans in the event of soaring food import bills. In November 2001, at the WTO Ministerial Conference at Doha, a decision was taken by the WTO to establish an Inter-Agency Panel on Short-Term Difficulties in Financing Normal Levels of Commercial Imports of Basic Foodstuffs. The terms of reference of the Panel were limited to assessing existing facilities like the CFF, and to examining the feasibility of the revolving fund.

The Panel Report did not express its verdict on the revolving fund in a definite manner (WTO, 2002).[30] It recommended that the feasibility of an *ex ante* financing mechanism aimed

[28] Comoros, Congo DR, Dominican Republic, Ethiopia, Kenya, Kyrgyz Republic, Malawi, Maldives, Mozambique, Senegal, St Lucia and the United Republic of Tanzania.

[29] ESF loans carry zero annual interest rate until 2011 (0.25 percent thereafter), with repayments made semi-annually, beginning 5.5 years and ending 10 years after the disbursement (see www.imf.org/external/np/exr/facts/esf.htm).

[30] The Members of the Panel were nominated by the respective heads of the FAO, IMF, IGC, World Bank and UNCTAD.

at food importers should be explored further. Developed countries - the potential donors to the fund - were not supportive of the idea. FAO and the United Nations Conference on Trade and Development (UNCTAD) elaborated further on how the proposed facility could work in practice and developed a proposal for the creation of a Food Import Financing Facility, FIFF (FAO, 2003). The FIFF was supposed to be a market-based instrument to provide credit guarantees to importing agents/traders of LDCs and NFIDCs to meet the cost of excess food import bills. Although it was seen favourably by many countries, there was no concrete interest for a practical follow up. Very little has been pursued in the WTO since then on this issue.

In retrospect, had it been in place, a functional instrument along the lines of the FIFF would have provided some relief to the affected countries during the recent periods of soaring food prices. It would also have reassured them about the world market being an affordable source of food supplies. The rationale for this proposal remains valid.

Concluding remarks

The desire to reduce uncertainty and volatility in world food prices and to reap the benefits from trade liberalization were the main reasons that brought agriculture into the regulatory framework of the WTO. The distorting policies in the agricultural sector, both at the border and in domestic markets, were targeted for reform and new rules and disciplines were agreed upon representing a fundamental shift in agricultural trade and food policy. By and large, border protection and domestic agricultural policies ceased to be subject to arbitrary decisions of individual countries and were placed under multilaterally agreed disciplines.

Yet, the AoA was only a very partial and incomplete first step in disciplining agricultural trade and adequately addressing the concerns of both exporting and importing countries, especially in periods of market volatility. In particular, as it has been demonstrated during recent periods of food price spikes, existing rules and disciplines are far from being fully effective and the Doha Round is not likely to change this situation drastically.

Comparing the two extreme cases of food price swings, the WTO rules and disciplines are much less effective in situations of high world market price years than they are in cases of depressed prices. This asymmetry is largely a consequence of the original objective of the multilateral trading system that aimed at disciplining situations leading to depressed prices in world markets adversely affecting exports. Thus, domestic and export subsidies, as well as import barriers, have been the target for reform, while policies that have to opposite effect (such as export taxes and prohibitions) have been largely tolerated.

This chapter argued that to the extent that the fundamentals of world food markets have changed, the multilateral rules must adjust accordingly to be able to address trade issues that may arise also in periods when food is dear. This would also add to the credibility of the MTS and foster an environment conducive to more trade openness on the part of importing countries, to the extent the latter are assured that the world market is a reliable source of supply, both in periods of plenty and in periods of relative scarcity.

Besides addressing certain imbalances and weaknesses of the trade rules, this chapter also pointed out the mechanisms envisaged in the AoA to help LDCs and NFIDCs facing difficulties in financing basic foodstuffs. Most notable is the need for an effective implementation of the Marrakesh Decision and the specific instruments therein. The Decision was a wise and insightful complement to the reform process in agriculture. A renewed effort is necessary to translate the good intentions of the international community into a functional instrument.

Ultimately, dealing with price volatility is the preoccupation of national governments and individual households within countries and cannot be addressed at the international level. However, the international policy environment, the multilateral trading system and the rules that govern it can be highly supportive and help countries mitigate the effects of extreme price swings. More symmetry in the rules in addressing problems of both exporters and importers, more predictability in the application of the rules and a more faithful implementation – not only of the letter but also of the spirit of the agreed rules – removes an uncertainty in the market and allows countries to focus on interventions with more confidence about the expected results.

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Chapter 18

Coping with food price surges

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Agricultural prices, along with the prices of primary commodities in general, were both high and volatile over much of 2006-10. These developments impact particularly acutely on the poor and other vulnerable non-farm households who devote a high proportion of their incomes to the purchase of food. Households are affected differently by changes in food price depending on their production and land ownership characteristics. In this chapter, we argue that the plight of vulnerable groups may fail to be apparent in aggregate statistics at the national level. In particular, a general improvement at the national level may occur at the same time that vulnerable groups suffer increased hardship from rising food prices. In designing policy responses to food price surges, governments and multilateral agencies must take into account the diversity of household situations and target policy at those most in need.

The summary argument is that compensatory finance schemes, aimed at offsetting temporary shortfalls in export revenues, have little relevance to the current period of high food prices as food-importing low-income countries do not primarily face a problem of lack of resources but instead wish to keep food prices, at least for vulnerable groups, relatively stable. Governments need to focus on reinforcing existing food security policies in which our preference remains for trade-based policies over national food stockpiles. Both the World Bank and the European Union responded to the 2006-08 high food price event plus financial crisis with useful short-term programmes, but these were based on the perception that the turmoil and crisis would be temporary. Instead, food prices are likely to remain high and volatile over the medium term. This calls for a different approach. We recommend that, where possible, this be based on a market approach to food security which would tend to reinforce trade-based food security policies and efforts to strengthen food markets where they are not working well (i.e. where government responses create disincentives for agribusiness investment). We recognize that other approaches may be required for countries importing foods where markets work poorly, rice being the obvious example.

The recent food price and volatility experience

An initial issue is whether we should be concerned by the level or the volatility of prices. These concepts are often confounded in popular discussion. Volatility refers to the variability

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of a price. As a matter of logic, it is possible for prices to be high but show little variability or to be low but variable. In practice, price levels and volatilities tend to be positively associated, in part because a low carryover from the past will reduce current availability, exerting upward price pressure, and will reduce the possibility of using inventory to meet positive demand or negative supply shocks, thereby increasing volatility (Gilbert & Morgan, 2010).[2] Typically, therefore, when prices are high they are also volatile.

High food prices erode the living standards of non-farm households. Volatile food prices result in these becoming vulnerable to such erosion. This erosion can be substantial for poorer households for whom food expenditure is the major budget item - a household with daily income at the poverty level of USD 1.25 per capita, spending 50 percent of its income on food and facing a 50 percent increase in food prices, will require a post-increase income of USD 1.56 per capita to purchase its original basket of goods. In most developing countries a large proportion of households will be only modestly above the poverty line and hence rises in prices of staple foods can substantially increase poverty. Volatile food prices are therefore of concern because they create the risk that more households will be brought below the poverty level.

Households will be affected differently according to their circumstances. Farm households will benefit from rises in world food prices and poor farm households may do so sufficiently to lift them out of poverty. As changes in food prices tend to be correlated with changes in the prices of non-food commodities, such as tropical export crops and metals, the same may be true of households engaged in these commodities - coffee or cocoa farmers and artisanal miners. While the overall effects of rising food prices may be complicated, the incidence will be adverse on urban households and on most landless rural households. We look at high food prices in the context of countries' terms of trade later in the chapter.

This discussion indicates that high and volatile food prices will impact most acutely on poor and other vulnerable non-farm households. While such households will be found in all economies, they will be particularly numerous in the poorest economies. For this reason, we focus on the impact of food price volatility on Low-Income Countries (LICs), as defined by the World Bank.[3]

World prices of grains and vegetable oils, which had generally been flat over the first half of the initial decade of the century, rose sharply from 2006-07. Figure 18.1 shows these rises for maize, palm oil, rice, soybeans and wheat over the period crop year 1990/91 - 2009/10. The prices are deflated by the United States Producer Price Index (all items) and normalized at 1999/2000 = 100.[4] The price rises were substantial with palm oil, rice and wheat doubling in price in 2007/08 relative to the 1999/2000 base and maize and soybeans increasing by more than three quarters. Despite rises in the late summer of 2010, prices have remained lower than those at the 2006-08 peak.

It is also apparent from Figure 18.1, that even at their 2007/08 peak, real prices were comparable with those in the late nineteen nineties. Wheat and rice prices were somewhat higher than at the earlier 1995/96 peak while maize prices were slightly lower. Both soybeans and palm oil were higher in real terms than at their previous peaks (in 1996/97 and 1997/98 respectively). A much longer perspective shows all five prices to be lower in real terms in 2007/08 than in the mid- and late-nineteen seventies.

It is also evident from Figure 18.1 that, although prices were variable over 2006/07-2009/10, this has also been true of previous high volatility episodes. It is well known that

2 Availability is carryover from the previous crop-year plus production in the current crop-year.
3 See http://data.worldbank.org/about/country-classifications
4 Source: IMF, International Financial Statistics.

Figure 18.1: Real food prices: 1990/91–2009/10

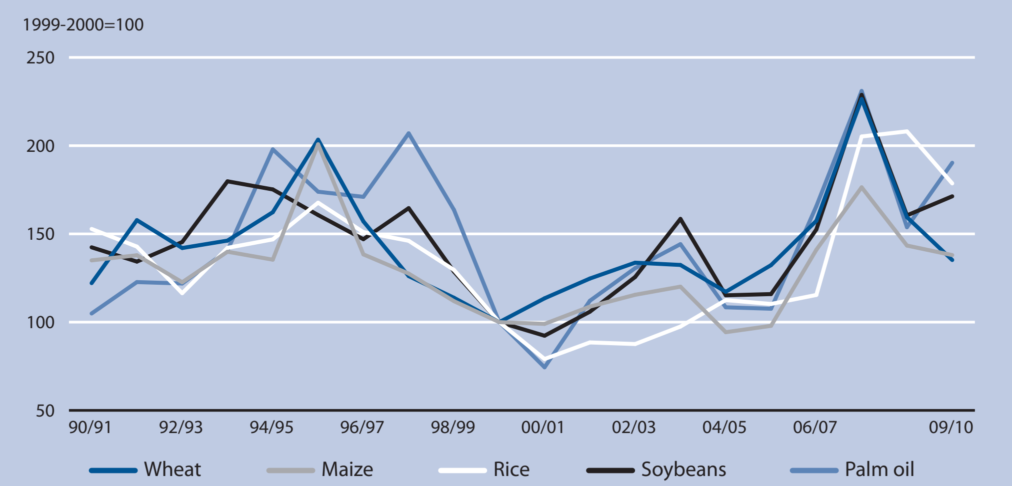

Table 18.1: Volatility in commodity prices (selected years)

Volatilities (selected years) %					
	Maize	Palm oil	Rice	Soybeans	Wheat
1971/1972 – 1974/75	22.4	38.9	22.7	34.0	33.7
1999/2000 – 2005/06	15.8	23.3	11.5	19.9	16.2
2006/2007 – 2009/10	28.5	31.8	28.0	24.7	32.4

Note: Intra-crop year volatilities of nominal returns at an annual rate, averaged over crop years.

periods of high volatility tend to bunch together. Table 18.1 compares volatilities over the most recent high volatility period (the four crop years 2006/07 to 2009/10) with that in the previous six crop years, over which time prices were very stable, and also with the high volatility period around the nineteen seventies commodity price boom (the four years 1971/72 to 1974/75).[5] Volatility was around twice as high for the three grains over 2006/07 to 2009/10 compared with 1999/2000 to 2005/06 but comparable with, or only modestly higher, than in the earlier high volatility period. In the case of palm oil and soybeans, the increase in volatility in 2006/07 to 2009/10 was less dramatic and these resulting levels were lower than those experienced in 1971/72 to 1974/75. These results accord with those reported by Balcombe (2011), Gilbert & Morgan (2010) and Huchet-Bourdon (2010).

As noted, volatility is positively associated with price levels. Taking the forty year period 1970/71 to 2009/10, the correlations range from 0.17 for rice to 0.63 for soybeans.[6] Perhaps less obviously, high volatility is associated with high cross-commodity correlations: averaging volatilities across the five commodities, this shows a correlation of 0.42 with the intra-

5 Volatilities are calculated as the standard deviations of monthly nominal returns (changes in the logarithms of monthly average prices) within each crop year averaged over crop years.

6 Maize 0.22, palm oil 0.24, wheat 0.42.

crop year cross-correlations of the five commodities.[7] Price co-movement therefore tends to increase in periods of high volatility. We therefore tend to see periods in which food prices in general are high and volatile. This was true of the period from the end of 2006 as it was in the first half of the nineteen seventies.

These numbers demonstrate that, although the prices of food commodities were both high and volatile over the period from the end of 2006, neither the levels nor the variability of these prices was historically unprecedented. The shock of high and volatile prices is to be seen in the context of the low and stable prices over the so-called Great Moderation and the likely impact of these developments on attainment of the Millennium Development Goals.

Food prices and the terms-of-trade

Economists often measure the overall impact of changes in world prices on a particular country by the terms-of-trade, defined as the ratio of the country's export to its import prices. If food prices had risen in isolation, they would have implied a deterioration in the terms of trade of food importing countries.

The-terms-of trade are a very imperfect welfare measure. They do not take into account movements in the prices of non-traded goods (including staple foods) or of goods which are not traded at current border prices as the resulting redistribution of welfare is internal. Neither do they take into account the incidence of price changes across households which may be quite different for imported and exported goods. There are also practical problems in measurement. Products only have uniquely defined prices in economics text books. In practice, even narrowly defined products will be bought and sold at different prices depending on precise grades or product specifications, the quantity and location of the transaction and delivery conditions and the bargaining power of the parties involved. This makes it problematic to obtain a practical measure corresponding to the theoretical concept.

There are two approaches. First, trade statistics, such as those for agricultural goods in FAOSTAT, provide estimates of both the United States Dollar value and the quantities of imports and exports of narrowly defined products. These data allow one to infer unit values (the ratio of United States Dollar values to quantities) which may be interpreted as the prices which, when multiplied by the reported quantities, generate the reported United States Dollar values. There are well-known problems with these methods. First, they fail to take into account quality-improvements in manufactured goods with the result that unit values tend to exaggerate the extent of price increases. For LICs, who import most manufactures, this will lead to a general tendency to over-estimate the decline in the terms-of-trade over time (Lipsey, 1994). Second, reported values may reflect the effects of hedging, transfer pricing and other practices (some legal and some illegal) which distort unit values away from the original prices they are supposed to represent.

The second possibility is to use world prices. These are well-defined for most primary products, including food products, but do not necessarily relate closely to the prices particular countries pay when importing or receive when exporting. Furthermore, clearly defined world prices are only available for primary products, but even in these cases, they may not accurately reflect the prices at which countries trade. In part, this can be because of grade and quality differences, in part because transport costs may drive a wedge between a country's fob prices

7 The ten cross-commodity correlations are averaged for each crop-year. The correlation of this average correlation with the average deflated price is also positive at 0.25. High cross-commodity return correlations are indicative of common demand shocks - see Chapter 11.

Table 18.2: Changes in price indices and primary terms-of-trade, selected Low-Income Countries: 2005-2008 and 2010

	Price indices			Terms of trade	
	All imports	Food imports	All exports	Raw	Adjusted
Percentage change 2005 - 2008					
Benin	50.5	38.4	36.7	- 9.2	- 14.2
Kenya	38.2	53.6	38.6	- 8.3	- 10.1
Malawi	44.9	51.8	34.6	- 7.1	- 13.1
Nepal	45.4	53.7	33.6	- 8.1	- 13.2
Percentage change 2005 – 2010 H1					
Benin	32.0	24.8	46.0	10.6	1.9
Kenya	23.8	39.7	39.3	12.5	7.6
Malawi	30.8	29.8	52.4	16.6	2.7
Nepal	30.2	37.0	43.5	10.2	0.9

Note: The first four columns of the upper panel of the table report the changes in the price indices from 2005 (year average) to 2008 (year average). The lower panel reports the changes to 2010 (January-June average). Column 4 reports the same changes for a primary terms of trade index defined as the ratio of the primary export (column 3) to primary input (column 1) indices. Column 5 adjusts these estimates to take into account lack of balance between import and export values based on average trade values over 2006-08. Source: Gilbert (2010).

and world prices and in part because the supposed world price does not closely correlate with the prices which countries pay for food imports - see Chapter 7 in relation to the world rice price.

Gilbert (2010) uses this second procedure to consider the primary terms-of-trade, being the ratio of primary export to primary import prices calculated as base-period value-weighted averages of world prices for 67 major primary commodities, for four LICs - Benin, Kenya, Malawi and Nepal. These statistics are reproduced in Table 18.2. The final column adjusts the crude measure to take into account the fact the value of primary imports exceeds the value of primary exports and supposes no change in the balancing flows. Over the four year period 2005-08, the four countries saw increases in import prices ranging from 38 percent (Kenya) to 51 percent (Benin) but export prices also increased by between 34 percent and 39 percent.[8] The resulting term-of-trade deterioration was therefore a more modest 10 percent (Kenya) to 14 percent (Benin). Furthermore, this deterioration had been reversed by mid-2010 as import prices fell back but export prices continued to rise.

The implication is that high and volatile food prices from 2006 have not, in general, translated into an adverse movement in the terms of trade for LICs. This is because the rise in agricultural prices has happened at the same time, and for some of the same reasons, as the rise in energy and metals prices. LICs have low manufacturing exports and rely on

[8] Weights are import and export value shares averaged over 2004-06 - see Gilbert (2010) for methodology and data sources.

primary exports, together with remittances and overseas assistance, to cover their imports. Many LICs have therefore benefited as much or more, at the aggregate level, from rising export prices as they have suffered from rising import prices.

The relatively little movement in terms-of-trade over the most recent years does not imply that high and volatile food prices have had no effect as the incidence of rising export prices will generally have been different from that of rising import prices. Furthermore, the trajectories of the prices consumers in different LICs were required to pay may have differed significantly from those of world prices (Gilbert, 2011). What the result does imply is that aggregate measures of well-being can conceal the impact of high food prices on vulnerable groups. It follows that policy should be more concerned with the form and direction of assistance than with the level of resources provided.

Compensatory finance schemes

Compensatory finance schemes formed an important plank in international commodity policy aimed at assisting countries in adapting to volatility in the prices of their export goods. They emerged in the late nineteen seventies and the nineteen eighties when commodity prices were generally falling. The main schemes which we cover are the IMF Compensatory Financing Facility (CFF), the European Union STABEX facility and the FLEX facility which replaces STABEX. The issue we examine here is whether these schemes have lessons for the current period in which LICs face volatile food import prices but in the context of generally strong export prices.

The IMF's CFF was created to help countries which experience a sudden loss of export income or a sudden rise in imported cereal prices owing to fluctuating world prices.[9] It suffered from strict eligibility requirements and costly financial terms and as a result, countries were often able to secure better loan terms with fewer conditions from different facilities. The CFF was not used after 2000 and was officially abolished in April 2009.

The CFF generally failed to accomplish its primary goal: stabilization of export earnings. And even in those countries for which it did achieve some success in stabilizing, this was temporary and on the whole insignificant in terms of overall impact (Finger & deRosa, 1980,Lim, 1987, Lim, 1991; and Herrmann et al., 1990). The CFF was criticized for the significant compensation time-lags: it not only failed to effectively stabilize export earnings, it even had destabilizing effects as transfers became pro-cyclical (Brun J & Laporte, 2001).

The main benefit for those countries which made use of the CFF was that of an additional IMF window. Although disbursements were triggered by shortfalls in exports earnings, repayments were not contingent on the subsequent recovery in exports revenues. As repayments were governed by the CFF loan schedule and the loan was subject to a below market interest rate, countries typically chose to remain with the repayment schedule rather than to repay as their export earnings increased. This lack of symmetry of disbursements and repayments on the scheme had the result that the CFF became a source of general development assistance (Lim, 1987) undermining "the unique function" (Finger & deRosa, 1980) that the scheme was designed to fulfil.[10] Nevertheless, the facility may have been valuable despite the fact that it was not stabilizing.

9 The IMF CFF and ESF schemes are also discussed by Konadreas (2011) in this volume.

10 Finger & deRosa (1980) claimed that as countries chose "not to make repayments in such a way as to increase export stability indicates that they do not consider stability a particularly important benefit". That argument is invalid - once the CFF loan was in place, governments naturally chose to repay in the least cost manner.

Prior to its abolition in 2009, the CFF was modified on a number of occasions. Originally, only shortfalls in merchandise exports were eligible for compensation, but the facility was expanded in 1979 to cover shortfalls in receipts from tourism services and workers' remittances. In 1981, coverage was expanded further to include excess cereal import costs. An oil element was temporarily introduced in 1990 to compensate for increases in fuel import costs in the run up to the first Gulf War, although it was allowed to expire at the end of 1999 (see IMF, 2004). The final pre-abolition change, in 2000, concerned drawings under balance of payments weaknesses. It was also established that CFF would be available in the context of an IMF arrangement. This modification reflected the recognition that the stand-alone mode of CFF assistance was rarely likely to be appropriate as the balance of payments assistance would normally need to be associated with adjustment programme. Effectively, the CFF became "mainstreamed" within standard IMF assistance programmes. It was then only a matter of time before it was absorbed by them and ceased to exist as an additional facility.

In addition, two other smaller but continuing IMF schemes qualify to be included in the compensatory finance suite. The Exogenous Shocks Facility (ESF) was established by the IMF in 2006 to provide quick and easy access to concessional financing for LICs facing exogenous shocks such as adverse commodity price swings, natural disasters, and conflicts or crises in neighbouring countries. Conditionality is focused on measures needed to adjust to the shock, with less attention to the structural adjustment measures more commonly associated with Poverty Reduction and Growth Facility (PRGF) assistance, now renamed as the Extended Credit Facility (ECF). In 2008, access was made more flexible and the earlier requirement that countries must have PRGF in place was dropped. Just two ESF arrangements were active in November 2010 (out of a total of twelve granted up to that date), as against 29 arrangements under the ECF.[11]

The Standby Credit Facility (SCF) provides financial assistance to LICs with short-term balance of payments needs. The SCF was designed as part of a broader reform to make the Fund's financial support more flexible and better tailored to the diverse needs of LICs, including in times of shocks or crisis. It provides support under a wider range of circumstances, allows for higher access, and can be used on a precautionary basis. As with the ESF, just two SCF arrangements were active in November 2010.[12]

Turning now to the European Union facilities, the STABEX scheme operated over the period 1975-2000 as part of the succession of Conventions signed by the European Union member countries and the African, Caribbean and Pacific Group of countries (the ACP). Its aim was to remedy "the harmful effect of the instability of export earnings" by providing compensation for shortfalls in the export earnings of the ACP states, caused by price or quantity fluctuations, or both. With many governments dependent on export taxes, often levied on an ad valorem basis, declines in export revenues translated directly into declining tax revenues. Budgetary support was intended to finance government expenditure over what was seen as likely to be temporary shortfalls in tax revenue.

The European Union STABEX scheme was an all-grant scheme, targeted on selected agricultural commodities only, excluding products such as sugar, meat and tobacco, which were crucial for many of the ACP countries. It was designed to deal with the budgetary effects of export earnings instability on the developing countries and not with the causes of this instability. The conditionality revisions in the four Lomé Conventions highlight changes in the objectives of the scheme but also underline its implications.

11 For Ethiopia and the Maldives. See IMF Financial Activities - Update November 18, 2010: http://www.imf.org/external/np/tre/activity/2010/111910.htm

12 Honduras and the Solomon Islands.

The early STABEX schemes can be seen as complementing domestic marketing board and *caisse de stabilisation* schemes to stabilize domestic prices - see Knudsen & Nash (1990) for a review. STABEX provided governments with the revenue support, while the domestic schemes protected farmers against short-term price fluctuations. The extreme flexibility in allocating compensatory funds built into the design of the Lomé I scheme gave governments the option to use the funds to assist diversification among other possible objectives. As these domestic schemes broke down or were either abandoned or modified in the period 1985-1995 market liberalization process (see Akiyama et al., 2001), STABEX moved towards greater sectoral focus and increased conditionality in order to ensure direct support to the farmers. The flexibility in the early schemes was replaced by requirements that funds be directed towards the sectors suffering from export decline. This blocked the diversification option and created an incentive towards further concentration of exports. In conjunction with tighter funding limits, increased conditionalities also slowed disbursement.

SYSMIN was the mineral twin brother of the agricultural STABEX. It operated over the period 1980-2000. It was targeted at the alleviation of fluctuations in revenue arising from the production and sale of minerals (bauxite, aluminium, copper, cobalt, iron, tin, phosphates, manganese and uranium). The precious metals were excluded from the product coverage. The twins were not identical reflecting the domination of the minerals sector by mining companies. SYSMIN funds were allocated to governments but could be transferred to mining companies "in need of restructuring, with a view to preventing difficulties in the future" (European Commission, 2000). Otherwise, the design of the scheme was similar to STABEX as were the problems associated with its operations. In addition, owing to its eligibility criteria SYSMIN was criticized as unfairly favouring only a small group of ACP countries (Maennig, 1988; European Commission, 2000). Country evaluations of SYSMIN signalled problems in project identification and project design. More specifically, the process of project identification and preparation was significantly under-funded with less than 1 percent of the project cost allocated for this purpose, while standard practices suggest a budget of 3 percent to 5 percent of the expected total project cost for the identification and preparatory stage (European Commission, 2000). The complexity of the procedures for project appraisal and execution have been cited as crucial factors in hindering the rapid and effective utilization of SYSMIN resources (ACP, 1999).

An important characteristic of both STABEX and SYSMIN was the commodity-by-commodity structure, i.e. fluctuations in one sector could trigger a compensatory transfer regardless of what happened with aggregate export receipts at the country level. This raised two important issues. First, the scheme was imperfectly counter-cyclical as it was possible to obtain compensation for falling export earnings of one commodity at the same time as the overall balance of payments was improving (Hewitt, 1993, Brun J & Laporte, 2001). Second, STABEX was never intended to directly stabilize total export earnings of the countries. Instead, it aimed to contribute to the reduction of total export earnings instability indirectly by stabilizing farmers' income. As Aiello (1999b) has noted, the stabilization of export earnings of triggering sectors alone is not "sufficient to establish a sounder economic structure in each ACP economy". Empirical research demonstrates this and shows that while STABEX was successful in stabilizing export earnings of the sectors concerned (Aiello, 1999b), it had a negligible stabilizing impact on total export earnings (Aiello, 1999b, Lim, 1991, Brun J & Laporte, 2001, Faber, 1984, Herrmann et al., 1990). The product coverage and time lags between the occurrence of the export shortfall and the date of disbursement, caused by the complex analysis for the justification of payments (Brun J & Laporte, 2001), also contributed to this unsatisfactory result. As a consequence, the literature has tended to regard STABEX, like the CFF, as an aid allocation mechanism more than a stabilization scheme (Hewitt, 1993).

The European Union responded to the unsatisfactory operation of STABEX and SYSMIN with the establishment of the Fluctuations of Exports scheme (FLEX) in 2000. As the view became prevalent that mandating a large part of European Union development funding to the "traditional" commodities was not efficient from a general development standpoint and that these schemes did too little to encourage diversification, the European Union reincorporated the STABEX and SYSMIN funds within the overall development budget. Like the CFF, STABEX and SYSMIN were mainstreamed. FLEX incorporated the principles of the predecessor schemes, but its design implements the lessons learned from the operational problems of its predecessors. Firstly, the new scheme aims at faster disbursement of funds to eligible countries, and secondly, disbursement is triggered by losses of overall export earnings as opposed to the commodity-by-commodity operation of STABEX and SYSMIN, and in the context of the country's overall development potential and attainments.

It is fair to say that the expectations raised by FLEX have largely disappointed. It has been criticized for its complex procedures, slow disbursements and insufficient resources.[13] These factors have contributed to FLEX failing to achieve its objective - see Griffith-Jones & Gottschalk (2005), Griffith-Jones & Ocampo (2008) and Aiello (2009).

Compensatory finance is inevitably backward-looking. Slow speed of disbursement was an endemic problem with both CFF and STABEX-SYSMIN-FLEX with the result that neither did much to reduce the variability of government receipts. In some cases, in which disbursements coincided with price upturns, outcomes may have been pro-cyclical (Collier et al., 1999; Brun J & Laporte, 2001; Hewitt, 1993). This has driven the movement towards mainstreaming.

If they are to be defended (few economists have risen to this task), this must be as ODA (overseas development assistance) in the form of uncommitted budgetary support to governments of countries which had, at some earlier date, suffered a substantial decline in export earnings. They should be judged against the criteria for general development assistance (Lim, 1987; Finger & deRosa, 1980; Aiello, 1999a). The important questions in relation to recipient countries is whether this assistance was additional to that which would have been forthcoming otherwise, and the extent to which assistance was diverted towards countries which had either greater needs or where the assistance was more valuable. Neither the academic nor the policy literature has much to contribute on these questions.

A (see Chapter 11, the compensatory finance history has only limited relevance to the current environment of high and volatile food prices. We have seen that LICs have not in general suffered from declining terms-of-trade over the recent period as their export prices have been buoyant. LICs have faced the problem of how to spend their buoyant export revenues effectively, and to what extent they should save part of these revenues, and not revert to the shortfall problem which the compensatory finance schemes addressed. As stressed in earlier discussion, the current problem is not one of resource availability *per se*, but rather how resources can be directed towards poor and vulnerable households hit by rising food prices but not necessarily in receipt of elevated export revenues.

[13] For example, in 2003 a total of 17 countries met the eligibility criteria for FLEX support. However, only 13 received financing because the other four country-specific resources were already exhausted (Griffith-Jones & Ocampo, 2008). The FLEX budget includes a ceiling for every ACP country.

Global safety nets

Global safety net schemes emerged onto the multilateral stage as a specific response to the 2008 financial crisis and to the coincident rise in the prices of food commodities. It was widely recognized that the sharp decline in the prices of industrially-consumed commodities has the potential to cause problems for many commodity-exporting countries, but that these declines, albeit severe, were also likely to be temporary. Rises in food prices do not generate a need for budgetary support, at least in the first instance. Rather, they require that governments develop or enhance targeted domestic safety net policies to maintain the living standards of poor households whose dependence on purchased food will make them particularly vulnerable to rises in food prices. Multilateral support therefore needs to be directed towards reinforcement of countries' own Poverty Reduction Programmes. The World Bank has led the pack in this direction.

The World Bank's Vulnerability Financing Facility (VFF) is a dedicated facility designed as a response to the financial and economic crisis to streamline support to the poor and vulnerable. The VFF combines two separate programmes: the pre-existing Global Food Crisis Response Programme (GFRP) and the new Rapid Social Response (RSR) Programme that focuses on social interventions. Both programmes provide technical and financial assistance to support governments in their immediate and longer-term crisis responses. It is currently intended that the VFF will terminate at the end of 2011.

The GFRP, created in May 2008, is a fast disbursing facility designed to assist countries to respond to the recent high food price event. It aims to reduce the negative impact of high and volatile food prices on the lives of the poor. It also aims to assist countries in the longer run by supporting governments in the design of policies to mitigate the adverse impact of volatile food prices and supporting farmers in production strategies that enhance productivity and reduce their vulnerability to future crises. The programme is financed through World Bank resources and several external-funded trust funds. As of January 2011 GFRP has approved a total of USD 1 443.6 million and 75 percent of the approved funding has been disbursed. World Bank-funded GFRP projects amount to USD 1 238 million in 35 countries and 80 percent of these funds have been disbursed - see Table 18.3. Additional USD 205.4 million have been approved under externally funded GFRP trust funds.[14] The size of the facility was increased to USD 2 billion in April 2009 and in October 2010 it was extended to June 2011, amid concerns over heightened food price volatility.

The GFRP envisages three types of intervention:

- Policy instruments to reduce consumer prices through targeted reductions in food taxes and import tariffs.
- Safety nets to provide access to cheap food to the targeted poor. According to de Janvry & Sadoulet (2009), 68 percent of participating countries followed this approach.
- Financing and technical assistance focusing on agricultural supply response, in particular through the supply of seeds and fertilizer and investment in improved irrigation for small-scale farmers.

GFRP funds are channelled through two types of financing: development policy operations (DPOs) and investment loans. Table 18.3 shows the breakdown between the two categories up to September 2010. Development policy operations (DPOs) are quick-disbursing budget support measures, designed to be delivered more quickly than standard International

[14] These include 10 Multi-Donor Trust Fund-funded projects, two Russian Federation Food Price Crisis Rapid Response Trust Fund-funded operations, and 11 European Union Food Crisis Rapid Response Facility-financed operations.

Table 18.3: World Bank-funded projects under the Global Food Crisis Response Programme: status as of January 2011

Country	Approved amount (USD m)	Type of financing	Approval year
Afghanistan	8	Investment loan	2008
Bangladesh	130	DPO	2008
Benin	9	Investment loan	2008
Burundi	10	DPO	2008
Cambodia	5	DPO	2009
Central African Republic	7	Investment loan	2008
Comoros	1	Investment loan	2009
Djibouti	5	DPO	2008
Ethiopia	275	Investment loan	2008
Guinea	10	Investment loan, DPO	2008
Guinea-Bissau	5	Investment loan	2008
Haiti	15	Investment loan, DPO	2008, 2009
Honduras	10	DPO	2008
Kenya	55	Investment loan	2009
Kyrgyz Republic	10	Investment loan	2008
Lao People's Democratic Republic	5	Investment loan	2009
Liberia	10	Investment loan	2008
Madagascar	22	Investment loan, DPO	2008
Mali	5	DPO	2008
Moldova	7	Investment loan	2008
Mozambique	20	DPO	2008
Nepal	83.8	Investment loan	2008, 2010
Nicaragua	17	Investment loan	2009, 2010
Niger	7	Investment loan	2008
Philippines	200	DPO	2008
Rwanda	10	DPO	2008
Senegal	20	Investment loan	2009, 2010
Sierra Leone	10	Investment loan, DPO	2008, 2009
Somalia	7	Investment loan	2008
Southern Sudan	5	Investment loan	2008
Tajikistan	9	Investment loan	2008
United Republic of Tanzania	220	Investment loan	2009
Togo	7	Investment loan	2008
West Bank and Gaza	8.4	Investment loan	2008, 2010
Yemen	10	Investment loan	2008

Source: World Bank GFRP Project Status http://www.worldbank.org/foodcrisis/pdf/GFRPProjectStatus.pdf.

Development Association (IDA) and International Bank for Reconstruction and Development (IBRD) operations. The World Bank claims that disbursements typically start immediately after Board approval and prior to completion of all project administrative and project procedures. They also state that several GFRP projects have been processed within eight weeks of the start of the application procedure. Investment loans finance investment operations that focus on the long-term (5 to 10 years) and finance goods, works and services that support economic and social development projects.

The major success of the GFRP has been its record rapid disbursement but arguments remain as to whether the assistance has been on a sufficient scale. De Janvry & Sadoulet (2009) argue that, with nominal tax rates of only around 10 percent, compensation of governments for the revenue loss arising out of reduction of import tariffs on food has little effect in the face of price increases of the order of 150 percent . That argument supposes a unit pass-through. In practice, pass-through may be substantially less than this in which case a 10 percent offset becomes more important. These same authors also argue that while for the majority of recipient countries GFRP funds target safety nets, these may not always encompass the most vulnerable. For example, many of the rural poor will not be covered by school feeding programmes. To the extent that domestic safety nets lack coverage, this will also be true of GFRP assistance; but equally, to the extent that domestic safety net programmes do assist vulnerable groups, the GFRP will enhance their ability to do so in the context or high and volatile food prices.

The GFRP is designed explicitly as a short-term means of mitigating the impact of high food price swings. Agricultural investment development remains the best long-term food security strategy and in most LICs this will imply development of smallholder agriculture (Abdulai & Delgado, 1995; de Janvry & Sadoulet, 2009). In the context of the G20 food security agenda, World Bank President Robert Zoellick noted that "Eighty-six percent of staples in poor areas come from local sources, so support for country-led efforts to bolster smallholder agriculture is critical".[15] The Global Agriculture and Food Security Program (GAFSP), a multilateral trust fund founded in April 2010 that specifically targets structural agricultural and food security programmes in LICs, complements the GFRP in the provision of longer term financing.[16] As of January 2011, GAFSP has awarded a total of USD 321 million to 8 countries. For each country the funds are implemented through the World Bank or Regional Development Banks such as the African Development Bank. Table 18.4 provides details on recipient countries and amounts approved under the GAFSP.

The GAFSP finances longer term projects in LICs that are vulnerable to rising food prices and have weak capacity to provide social safety nets. For example, in Ethiopia the funds support programmes for sustainable increase in rural incomes and national food and nutrition security, particularly by developing the potential of well-endowed areas. In the Niger the aim is to increase the availability of agricultural products through water harnessing and to support the development of small scale irrigation. In Mongolia the financing aims to raise the productivity and quality of livestock, increase access to domestic and regional markets for livestock commodities, improve market information systems, and strengthen the capacity of producer groups and cooperatives. The financing for Rwanda targets projects aimed at the reduction of hillside erosion, while for Haiti the goal is to improve access to seeds, fertilizers and agricultural technology.

The Rapid Social Response Program (RSR) is the second window under the World Bank's VFF alongside the GFRP. The RSR is a new programme designed to assist countries address

15 "Free markets can still feed the world", Financial Times, 5 January 2011.

16 See: http://www.gafspfund.org

Table 18.4: Global Agriculture and Food Security Programme: status as of January 2011

Country	Amount (USD m)	Approval date
Bangladesh	50	June, 2010
Ethiopia	51.5	October, 2010
Haiti	35	June, 2010
Mongolia	12.5	October, 2010
Niger	33	October, 2010
Rwanda	50	June, 2010
Sierra Leone	50	June, 2010
Togo	39	June, 2010
Total	321	

Source: GAFSP http://www.gafspfund.org.

urgent social needs stemming from the recent financial and economic crisis. The financing is aimed to: (i) help provide access to basic social services such as maternal/infant health and nutrition, and school feeding programmes; (ii) scale up existing safety net programmes and build capacity where such programmes are nonexistent; and (iii) assist in the income support of the unemployed, training, placement and similar employment initiatives. Projects focus on four general themes: improving the functioning of labour markets, social safety nets, social protection and risk management, and social risk mitigation. Under the RSR all IDA- and IBRD-eligible countries are eligible to access the fund which eliminates the need for further eligibility assessments and approvals and as such ensures a more timely disbursement of resources. As of November 2010, total allocations amounted to USD 12 billion, including USD 4.1 billion for fiscal year 2009, USD 3.9 billion for fiscal year 2010, and USD 3.9 billion for fiscal year 2011. The majority of allocations to date, 77 percent , have been towards social safety nets projects and around 20 percent of lending commitments have targeted IDA countries (World Bank, 2010).

The European Union's contribution to global safety nets is less extensive of than that of the World Bank. V-FLEX was an ad hoc short-term facility established by the European Commission in 2009 to address the budgetary consequences of the 2008 financial and economic crisis in the ACP countries. It was designed to ensure timely disbursement to cope with financing gaps as a consequence of the crisis providing financing, on request, to the most vulnerable ACP countries. Its total budget was EUR 500 million for the two year period 2009-10. The financing took the form of grants and provided primarily budgetary support intended to help countries maintain priority spending. V-FLEX allocations were based on forecasts of fiscal losses with the objective of ensuring timely disbursements to help ease the impact of the crisis. This was in contrast to FLEX which has been criticized for slow and untimely disbursements partly because eligibility is determined using historical data on exports. Although V-FLEX has the advantage of quick and sizeable disbursements, it is a temporary facility designed to disburse funds for a two year period only.

Table 18.5: Allocation of resources under V-FLEX for 2009-2010 (EUR millions)

	2009	2010	Total
Antigua and Barbuda		9	9
Benin	25	13	38
Burkina Faso		14	14
Burundi	14	15	29
Cape Verde		9	9
Central African Republic	8	13	21
Comoros	5		5
Democratic Republic of Congo		50	50
Dominica	5		5
Ghana	35		35
Grenada	5	4	9
Guinea Bissau	8	9	17
Haiti	30	26	56
Lesotho		21	21
Liberia		13	13
Malawi	25	19	44
Mauritius	11		11
Samoa		6	6
Seychelles	9		9
Sierra Leone	12	10	22
Solomon Islands	15		15
Togo		12	12
Tonga		6	6
Tuvalu		2	5
Zambia	30		30
Zimbabwe		16	16
Total	236	264	500

Source: European Commission. Amounts agreed for financing for 2009 and 2010.

V-FLEX resources were in addition to the EUR 1 billion European Union Food Facility adopted in March 2009 and the allocation of EUR 200 million under the European Development Fund (EDF) in 2008 to help developing countries cope with higher food prices. These grant resources are complementary to the loan-based assistance of the World Bank, the International Monetary Fund and other regional development banks. Table 18.5 lists allocations under the scheme.

Both the World Bank and the European Union have learnt from the compensatory experience in avoiding budgetary support and by designing rapidly disbursing assistance directly targeted at the most vulnerable groups. This is an appropriate policy response to the current turmoil, seen as short-term. However, if, now (2011) as seems likely high and volatile prices continue over a longer period of time, LIC governments will need to work towards enhanced food security, including through the development of a more efficient smallholder sector, and more comprehensive and inclusive safety net arrangements. The multilateral agencies can assist in this process.

Food security

The global safety net schemes discussed previously were conceived as stop-gap crisis response measures and, as such, they have enjoyed some success, but if food prices continue to be volatile and generally high, LICs and other developing countries will require longer term policies to address food security. Here, we address the policies available to them in limiting price volatility acting on a unilateral basis.

Increased food prices and the associated volatility have brought food security concerns back into prominence. Standard definitions of food security run in terms of the availability of adequate food and access to this food - see, for example, Pinstrup-Andersen (2009). We can think of food security at the national or the household level. Access problems arise at the household level as even if a country has potentially adequate food availability, not all households will have adequate access to food.

Maxwell & Smith (1992) discuss the relationship between poverty, vulnerability and food security. At the household level, food insecurity correlates with poverty. National poverty lines should be defined such that a non-poor household will have sufficient resources to purchase adequate food but, as poverty is a broader concept than food insecurity, not all poor households will necessarily lack adequate food (consider subsistence farmers with little cash income). Just as poverty statistics are snapshots, so are food security statistics based on availability measures. Vulnerability may be thought of as the probability that a non-poor, food-secure household finds itself poor or with inadequate access to the food in the future. In that sense, it is reasonable to state that a household is food-secure if it not only currently has access to sufficient food but if it can also reasonably expect continued access in the future. Many poor households will lack this guarantee even if they do currently possess adequate food.

At a national level, a country may be said to be food secure if it can guarantee adequate food to its citizens with a reasonable degree of certainty over the future, even if access problems may prevent some households from obtaining adequate food. This allows us to distinguish, at the national level, between precautionary and distributional food security policies, the former relating to continuing food availability and the latter to access.

Food security, in this precautionary sense, is not a problem in the major developed market economies. No developed economy experienced problems in obtaining the food its citizens required in 2006-08 and there does not appear to be any likelihood of food availability problems in the future. Contrast the situation of grains with energy where it is easy to envisage political conflict which closes the Straits of Hormuz drastically limiting petroleum availability. High food prices will erode living standards, even in developed economies. However, the share of food total household expenditure in the 1990s was less than 20 percent in all developed economies and as low as 8 percent in the USA (Mitchell et al., 1997). Because the farmgate share of many food products is also as low as 20 percent , a doubling of farmgate food prices will have a significant but not serious impact of around 1-5 percent on the overall household budgets, greater for the poor and less for the rich.

Food-importing countries

Food security remains important for many food importing developing countries. High food prices are likely to impact particularly on the urban poor and on landless rural households. These groups will typically have few assets on which to fall back and will be vulnerable in that adverse shocks may have negative impacts with much longer duration than the shocks themselves. Co-insurance at the family or village level is ineffective for common shocks which impact the insurer as well as the insured (Dercon, 2005). Developed economies use targeted social and family support policies to protect vulnerable groups of this sort. Targeting is less important in developing economies where larger and often more homogeneous groups are vulnerable. In these cases, there may be arguments for either public food security stocks or variable tariffs (or export controls for an export crop) to ensure that domestic grains prices do not rise too far or too fast.

The standard argument from economic theory that private stockholding will be adequate to control volatility loses its validity in poor economies. That argument is based on an absence of externalities and the ability of stockholders to offset their price exposure on futures markets - see Chapter 11. Futures markets will be absent or inaccessible in these countries. To the extent that it does store food, the private sector will do so to meet the likely purchases and not the needs of the poor and vulnerable groups. On top of this, policy risk may imply that they do even less than this. Because staple foods form a large part of the budgets of poor households, food prices and availability become acutely political issues.

Governments are therefore unable to credibly and effectively commit not to intervene in the event that a shortage arises. However, this makes it unattractive for private merchants to store grains until government has announced its intervention decisions. By the time governments have made these decisions, it is likely to be too late for the private sector to act effectively. In turn, governments justify intervention by reference to the unpreparedness of the private sector (Jayne & Tschirley, 2010). These problems are largely absent in middle income and developed economies in which governments typically follow policies based on pre-announced intervention rules. Finally, food price volatility may impose negative externalities (Gardner, 1979). The major impact of these externalities will typically be on supply chain intermediaries, in developing countries particularly acutely on locally-based intermediaries with limited access to credit and futures markets. The consequence is that such intermediaries will often operate at inefficiently small scale and will be at a competitive disadvantage relative to multinational competitors (Dana & Gilbert, 2008; Gilbert, 2009).

National food security policies can be through control of domestic marketing, by stockpiling or through trade policy, or a combination of these options. The right combination of policies is likely to vary according to whether the country is net importer or a net exporter of the commodity and whether imports or exports are normal or occasional (for example, in a broadly self-sufficient country which imports in occasional drought years). Policies may either be universal, as when governments intervene to limit rises in national prices, or targeted, as when governments allocate subsidized food to groups (such as school children or hospital patients) seen as being most in need.

Control of domestic marketing, for example through a monopoly-monopsony marketing board, allows government to stabilize prices in relation to local harvest variation. Monopsony-monopoly arrangements can result both in cost inefficiency, through elimination of competitive incentives to reduce intermediation costs, and distortions, through bureaucratically imposed pan-seasonal and pan-national prices. Governments can respond to high availability (i.e. a good harvest) by stockpiling or exporting excess production.

They can respond to a shortage by destocking, to the extent that they have carryover from previous years or importing, perhaps subsidizing the imports. Commitments to a fixed level or ceiling for food prices is fiscally dangerous - once introduced, subsidies are difficult to end, they destabilize the fiscal balance and unfunded commitments can lead to a potentially unbounded expenditures. In the end, the choice therefore remains between stock and trade-based stabilization, irrespective of the organization of marketing.

National food security stocks are particularly attractive for landlocked countries where transport costs are high and can also rise sharply in the event of an urgent requirement to transport large quantities. Nevertheless, the experience over a number of decades indicates that national stock policies have been costly - the grain is vulnerable to deterioration, they tie up scarce resources, they are vulnerable to corruption and theft and, like internationally held stocks, they discourage private stockholding. In an authoritative review, Knudsen & Nash (1990) concluded that stabilization schemes should "avoid handling the commodity when possible". If other options are available, they are likely to be preferable. Nevertheless, and contrary to the view expressed by Knudsen & Nash, the Asian experience with national rice stockpiles has been generally positive - see Sicular (1989) and Timmer (2010).

Timmer (1986) argued for a move away from national food security stocks towards food security via trade and production based on comparative advantage. This view was reflected in the policy advice offered by the multinational development agencies over the two decades prior to the recent food price surge. If supply (harvest) shocks are largely uncorrelated across countries, governments can import when they need to do so without, on average, paying high prices. A trade-based food security policy requires access to foreign exchange but does not tie up resources in those years in which supplies are adequate. It is less vulnerable to corruption. However, trade based food security works less well if imports are required at a time when a demand shock has driven up prices on world markets, and are less attractive in landlocked countries than in countries with good port access.

The response of rice exporting countries to export controls in 2006-08 and the similar response of the Russian Federation in wheat in 2010 have persuaded many developing country governments that trade fails to deliver on food security in precisely those circumstances in which it is required - see Christiaensen (2009). This has resulted in a reversal of the move towards trade-based food security and a revival of interest in food security stocks. Post-2008 attempts by countries to restore grain stock levels in what was already a tight market may have been a contributory factor behind the renewed rise in food prices in 2010.

The World Food Programme (WFP) makes a valuable contribution to food security in many LICs. In particular, WFP imports are often effectively targeted at the vulnerable. Nevertheless, it remains problematic to rely on the WFP as a strategy for dealing with food prices spikes. The WFP works against a nominal budget constraint and hence high grains prices will reduce the quantities of food that the WFP can supply. The budget constraint can be relaxed through appeals for additional funds, but this takes time forcing governments to make their own arrangements in the interim.

Of the major grain markets, it is that for rice which functions least well. It was also shortages of, and high prices for rice which generated most of the 2008 food price riots. A pragmatic approach might therefore distinguish between those countries which depend on wheat or maize imports, and those which depend on rice. In current circumstances, LICs can probably rely on being able to import additional maize or wheat if this proves necessary, but may justifiably be worried about being able to do so for rice. That points towards a need for contingency arrangements for rice - either a food security stocks, or formal trade agreements with rice exporters or, where this is feasible, a move towards rice self-sufficiency.

The most recent rise in food prices, which started in the 2010 northern hemisphere summer, has left food-importing LICs in a difficult position. This would be an expensive time in which to accumulate a food security stock but the 2008 experience has suggested to many governments and commentators that reliance on trade may be ill-advised. We argue that this conclusion is, in general terms, misconceived. Maize and wheat markets functioned well over 2006-08 and continue to function well now. The problem with these markets is the unpredictability of the prices that importers will need to pay, not availability of the grains themselves. It is this price unpredictability that governments need to address. Stockpiling is an expensive way to do this. We explore alternatives in the next section.

Food-exporting countries

Food exporting countries face a different situation. Prices obtained for exports relate to those on world markets. The price impact of supply and demand shocks to the world market will therefore be imported into domestic markets. Commercial policy - export taxes, quotas or outright restrictions - allow governments to insulate domestic prices from shocks to the world market. In countries which are close to self-sufficiency, export controls can be used in conjunction with a food stockpile to reduce the costs of stockpiling - see Timmer (2009). Because taxes and controls are typically imposed when world prices are high, they redistribute purchasing power from producers to consumers and from the countryside to the cities.

By insulating domestic producers and consumers from the world market, export restrictions and variable export taxes force the burden of adjustment on importing countries. In many cases, these countries may be poorer and less well-equipped to cope with the price volatility than the exporters. Widespread resort to controls reduces the depth of the world market and increases the volatility of prices on what can become a residual market of last resort. Variable export taxes result in incomplete or absent communication of price incentives for increased production to producers in exporting countries. Quantitative restrictions or bans on exports are likely to reduce availability at the world level at just the time shortages are occurring. Restrictions may also rebound on the exporting countries themselves as the possibility that a country may limit exports in a shortage situation reduces the attractiveness of exporters in that country as counterparties. Consequently, during normal export years, the country will tend to export at a discount to world prices to cover its performance risk.

The world rice market is often believed to have this character. As noted above, the response of rice exporting countries to export restrictions in 2006-08 persuaded the governments of many food-importing developing countries that trade fails to deliver on food security in precisely those circumstances that it is required. Faced with this high volatility, importing countries find themselves obliged to institute food security stocks. Seen in this light, export restrictions generate a familiar Prisoners' Dilemma: both exporters and importers are better off if in the long-run if exporters forbear from restricting exports but the governments of exporting countries are unable to commit not to resort to such controls if they become expedient in the short-term. The consequence is a "bad" equilibrium in which importing countries run national food security stockpiles and aim for food self-sufficiency despite the high costs involved and exporting countries are unable to fully exploit their comparative advantage and their farmers are unable to profit from periods of high world prices.

How can the world escape from this "bad equilibrium"? There is a growing consensus for discussion of possible limitation of the use of export controls within the WTO. In this spirit, Fan (2010) has argued that "governments should be encouraged to eliminate existing export bans and refrain from imposing new ones". It would also be necessary to limit, but probably not prohibit, the use of variable export taxes because a sufficiently high tax is equivalent in its effects to an export ban. At the same time, any new protocol would need to recognize the right of exporting countries to take reasonable steps to limit the extent to which they import volatility from the world market. This will require a balancing of interests on both sides – see Chapter 17 for a discussion.

Overall, the lessons from domestic food price stabilization schemes in developing countries is that they can be successful in protecting countries against price shocks but they are also redistributive, perhaps unfavourably so, and can be expensive both in terms of domestic costs and the costs imposed on other countries. Export bans and restrictions, which can be effective in isolating domestic grains prices in exporting countries from shocks in the world market, have pernicious effects in increasing the impact of these shocks on importing countries. This argues for a new protocol, perhaps within the WTO, which would bind countries to limit actions of this sort.

A market-based approach to food security

The market approach to grains price volatility involves setting up structures and institutions which allow governments and supply chain intermediaries to cope with price volatility instead of attempting to reduce or eliminate this volatility and without resorting to extraordinary government intervention. This approach has been discussed in Dana et al. (2006), Sarris et al. (2006, 2011a,b), Dana & Gilbert (2008), Sarris (2010). While the global safety net schemes discussed earlier respond to food price spikes as and after they occur, the market-based approach aims to establish structures in anticipation of possible food price rises which, if effective, should obviate the need for the global safety net.

The principal instruments involved are futures and options contracts or "over the counter" (OTC) instruments, by means of which providers (usually international banks) intermediate the hedging instruments to the governments or entities concerned. Prior to the most recent decade, the use of these instruments was typically discussed in relation to protection of commodity exporters against price falls. However, they turn out to be even better suited to the protection of commodity importers against price spikes.

Consider a government which wishes to protect itself against a possible grains price spike. By buying futures contracts in the appropriate grain, the government locks in the grain purchase price. It will typically not take delivery on this purchase and will close out at the time it, or the national importing companies or agencies, purchase spot grain. On average, this hedge should neither lose nor make money and there will be a modest reduction in the variability of grain purchase prices. The major advantage to the hedger is that the purchase is known more or less accurately[17] at the time the hedge is initiated.

In practice, government access to futures contracts is likely to be constrained by credit requirements and the need for daily management of margin calls (which require immediate cash outlays), which can be operationally difficult to support. Additionally, futures may not

[17] The hedge is only approximate because of "basis risk", i.e. the fact that the country's import prices will be less than perfectly correlated with the exchange price. As basis risk increases, the usefulness of the hedge declines - see Dana & Gilbert (2008).

be a useful instrument for governments as there is an unknown liability associated with taking a futures position. If prices move down against a government that has entered into a long futures position (i.e. by buying futures contracts), the government will be responsible for paying, to the market counterparty, the difference in price movements. This is not likely to be a practical or palatable hedging strategy for Ministries of Finance in low income countries who will need to publicly explain, and be responsible for, the financial outcomes of the hedging strategy.

An alternative to hedging with futures contracts is hedging with option contracts, which allow a government to secure price protection at a certain level in return for a fixed premium which is usually paid in advance. For importers, a call option has the effect of putting an approximate ceiling price on the contracted quantities. A ceiling price is particularly attractive if the intention is to hedge against a price spike in which case the "strike" (i.e. contractual ceiling) price of the call option can be significantly above the market price level at the time of contracting. This is called purchasing an "out-of-the-money" option.

A major advantage of the call strategy is that it has a market price. The cost of protection is therefore known (and will typically also be paid) in advance. Purchasers can decide on the level and duration of protection that they require or can decide that the cost is too high and they prefer to remain unprotected. In developed and middle income economies, the cost of staple grains is no longer a major component of household budgets and the resulting diversification implies that self-insurance is likely to be the preferred outcome. On the other hand, many LICs may value this type of price protection. Others may regard it as inappropriate or too costly. Call options can be structured either on a purely financial basis (i.e. using exchange-traded contracts), or on a physical basis (i.e. by integrating the price "cap" into a purchase or supply agreement). In countries where food import prices are not closely correlated with world prices (the basis risk problem), physical option strategies (i.e. contingent purchase agreements) might be more suitable. For many LICs, interest in a purely financially settled product may not be useful as it would not result directly in food shipments moving into the country, typically an important priority for a country facing a shortage or food price shock. Finally, governments may decide that the funds required for payment of the premium could be better spent on other projects. The result of these complex dynamics will be that this sort of strategy becomes appropriate for those for whom it has the greatest value. As a result, it may be significantly less costly than the establishment of an international grain reserve which will offer a uniform (but low) degree of protection to all grains consumers.

In general terms, the cost of "out-of-the-money" call-based protection for 12 months for a single government or intermediary, will range from 7-12 percent of the value of the commodity protected. In landlocked countries, transport costs from the nearest port or railhead can be substantial and can also be highly variable. Ideally, the contract should also lock in transport prices - see Dana & Gilbert (2008). Such countries will need to evaluate whether they are better protected by national food security stocks or through call-based protection. There is no clear a priori answer to this question. In addition to governments, market intermediaries might also choose to use call options. If governments wish to encourage this approach they can create incentives for traders and suppliers who hedge, for example by reducing import tariffs or by directly co-financing premium payments.

Although these approaches are not likely to be useful as a general panacea against food price spikes, there is scope for looking at the way these approaches could be customized to help provide a cushion against price spikes, and create the basis for better signalling to market actors about the intentions of government. To the extent that this form of hedging does impact prices, it should also stimulate additional storage as storage companies would form natural hedge counterparties.

Market-based protection against grains price spikes is feasible for many countries and is likely to be affordable for at least some. The fact that not all governments will wish to purchase this form of protection is probably an advantage as it will ensure funds are not wasted. Unlike public storage, this approach also encourages additional private storage and trade finance. These additional benefits in terms of strengthening the roles of private actors suggest that these ideas deserve further and wider discussion. They should be seen not so much as substitutes for the global safety net arrangements discussed previously but rather as an evolution of these arrangements such that a new arrangement does not need to be negotiated every time that food prices move up. They may be seen as reinforcing trade-based food security policies and thereby obviating the need to retreat back to more expensive stock-based policies.

A role for the international community?

Food security problems may either be local or global. Local problems arise as the result of a crop failure, civil war or some other disruption in a particular country or region. Examples are the periodic droughts which affect many Southern African countries. Global food security problems arise when there are food shortages at the world level which drive up the prices food importing countries need to pay for their supplies. Governments need to worry about both problems irrespective of origin, but local shortages can be adequately managed through a combination of trade and food aid, provided timely decisions are made. Trade helps less with global food shortages and high prices work to limit the availability of food aid.

The World Bank's VFF and the European Union's V-FLEX were both attempts to provide assistance to food importing developing countries in a situation which was, at the time the programmes were initiated, seen as temporary. That judgement no longer seems valid. The issue becomes how assistance of this form can be extended into the future.

One option would be simply to continue with VFF after its current end-2011 termination date. That would be feasible and, from the point of view of potential recipients, attractive, but it would also pre-empt resources from other valid development objectives. The FAO has also considered, but not implemented, a revolving scheme for financing food imports into LICs - the Food Import Financing Facility (FIFF). This proposal is discussed by Sarris (2010) and in 17 of this volume. The FIFF would aim to circumvent this constraint through multilateral guarantees for the finance for food imports at the margin. The scheme has not been implemented, largely because potential donors balk at the fiscal cost of a new set of guarantees.[18]

Both the VFF and the proposed FIFF are rationalized by the perception that food importing LICs are constrained by lack of finance and therefore have difficulty in meeting the additional cost of food imports resulting from a price spike. The terms-of-trade discussion earlier suggests that, on the contrary, the coincidence of high food prices with buoyant export revenues implies that the availability of foreign exchange should not be a problem. Indeed, by absorbing foreign exchange, food imports may help in the maintenance of competitiveness in the tradables sector. However, unless accompanied by subsidies, high price food imports will result in increased domestic food prices and hence impact negatively on vulnerable groups.

[18] Guarantees count as government liabilities and hence raise debt levels even though they do not imply a financing requirement unless exercised.

These arguments make the market approach, as outlined previously, attractive and suggest that donors might look for ways to assist LICs in organizing arrangements of this type. Many multilateral donors have long taken the view that trade-based food security policies are less costly and more effective than policies based on national food stockpiles. However, as noted earlier, trade-based policies proved unreliable in 2008 forcing many food importing LICs to incur additional costs in satisfying their food import requirements. A combination of an agreement to limit the use of export restrictions with the adoption of market-based food security strategies would go a long way to avoiding this outcome.

One possibility would evidently be to finance contracts of this form but this would detract from ownership and in any case may result in countries committing to contracts which offer them little value on the basis that any aid is valuable. Recognizing that derivatives contracts can be difficult to understand, an alternative would be for multilateral agencies to act as intermediaries. This would enable the agencies to work with government departments and food security agencies to evaluate needs and, either directly or through collaborators, provide appropriate contracts at a potentially lower cost than would likely be available to the countries themselves. Market counterparties would contract with the multilateral agency. Governments would pay the agency for the optionality elements of the contracts, and perhaps also a small fee, although such payments might come out of budgetary support funding, if available. They would remain responsible for their own import costs and hence would pay the provider if the contracts result in a physical exercise. Schemes of this sort might either be discretionary, based on crop forecasts, or be rolled over on an annual basis to provide continuous support.

Conclusion

High food price volatility is not the same as a high level of prices, but the two tend to arise at the same time. The five years 2005-10 have witnessed both volatile and high prices for the major food commodities on world markets. Prices rose sharply in 2007 and the first half of 2008, fell back in the closing months of 2008 and the first half of 2009 with the impact of the economic and financial crisis and have risen again, albeit to a more limited extent, in the second half of 2010. This volatility is high but not unprecedented and, along with the comparable volatility and high prices experienced in the markets for industrially consumed commodities, is probably the consequence of rapid growth in China and other emerging economies. The likelihood is therefore that both prices and volatility will remain high over the medium term unless there is a further interruption of emerging markets growth.

High and volatile food prices cause acute problems for poor and vulnerable non-farm households who spend a high proportion of their income on food. Although such households exist in all economies, Low Income Countries (LICs) generally have a high proportion of households who fall into these groups. There is thus a need for policy to address food price volatility.

Compensatory finance schemes have aimed at offsetting the budgetary impact of adverse movements in the terms-of-trade of commodity exporting countries. Despite rising food prices, LICs have not generally seen an adverse movement in their terms-of-trade and governments are not in need of budgetary support, or at least not because of high food prices. Instead, high and volatile food prices hit the poor and other vulnerable groups. Any multilateral assistance should therefore be targeted to reinforce countries' own domestic safety net policies.

Countries have available a variety of tools that they can use to stabilize food prices. Options differ depending whether the country is a food importer or exporter. Food exporters can use export restrictions or duties to insulate domestic consumers from the impact of volatility imported from world markets but this will be at the expense of their own producers, both in the short-term, when they are deprived at the possibility of selling at the high world prices, and in the longer term, as they come to be seen as unreliable counterparties. Furthermore, export restrictions exacerbate the food security problems of food importing countries. There are thus strong arguments for introduction of some limitations on the ability of countries to unilaterally impose such restrictions.

Food importing countries must rely on either trade or national food security stocks. There was a general movement over the two decades prior to the 2006-08 price spike in favour of trade-based policies. However, trade appeared unreliable in 2008 largely because food exporters acted to insulate themselves from the global price spike. These problems were particularly acute for rice importing countries. We have argued that, while it is probably preferable to reinforce rather than move away from trade-based policies in general terms, rice importers should consider non-trade based policies, both rice stockpiles and, where feasible, moves toward rice self-sufficiency.

The World Bank and the European Union both responded to the 2008 food price spike and subsequent financial crisis by establishing global safety net schemes with the objective of assisting countries in financing food imports. These schemes have been valuable but they were both set up as crisis response measures and for a limited duration. As high and volatile prices look likely to continue, what is now required is a longer term response.

We have argued that a market-based approach, reliant on the purchase of call options, provides the most attractive way forward. This approach would enable food importing countries to limit the impact of spikes in world food prices on their domestic markets and could be integrated with national food security structures. It is a natural extension of the trade-based policies advocated by multilateral donors prior to 2008. We have suggested a structure through which multilateral agencies would intermediate optionality such that costs and ownership remained with the countries themselves. Taken together with an agreement to limit use restrictions on food exports, the market-based approach can re-establish food security on a trade basis and obviate the need for costly national food stockpiles.

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Chapter 19

Using futures and options to manage price volatility in food imports: theory[1]

Alexander Sarris, Piero Conforti and Adam Prakash[2]

An important long-term development in world agricultural trade has been the shift - some two decades ago - of developing countries from being net exporters to a position of being net importers. Among developing countries, those classified as Least Developed Countries (LDCs) and Low-Income Food-Deficit Countries (LIFDCs) have witnessed a rapid worsening of their agricultural trade balance in the last fifteen years. The high price episode of 2006-08 brought this problem to the fore, in which the basic food import bills of LIFDCs increased by over 40 percent between 2007 and 2008, to USD 152 billion; and in 2010 imported food costs are expected to rise to a record USD 164 billion (FAO, 2010).

Analysis by Gurkan et al. (2003) indicated that the need to import food was an important determinant of economic stress in LDCs between the mid-1980s and 1990s. Their study showed that the growth in these countries' food import bills consistently outstripped that of GDP, as well as total merchandise exports. Changes in import unit costs of many important food commodities accounted for roughly two-thirds of the variation in food import bills. That same study also revealed that LDCs faced large and unanticipated price "spikes" that exacerbated their already precarious food security situation. Coupled with substantial declines in food aid over the same period, these developments have brought about a significant increase in the vulnerability of developing countries.

In light of the above developments, it seems that the issue of managing the risks of food imports has increased in importance, and is a major issue for several LIFDCs. The major problem is not price or quantity variations *per se*, but rather unforeseen and undesirable departures from expectations on food import needs, such as those that affected many countries during the 2006-08 period.

During this period, the combined increase of basic food prices, such as of wheat, maize and rice, with that of petroleum prices, created a "double squeeze" in many LIFDCs, which are large importers of both food and oil. African countries were most deeply affected (Demeke et al., 2011; FAO, 2008). In addition, given the simultaneous dependence of many of these countries on commodities both in importing and exporting, and with commodity prices tending not to move together, the likelihood of high import prices, coupled with low export prices is a real concern and presents new challenges for policy-makers. It thus becomes imperative to explore possible national strategies to deal with food import risks.

1 This chapter is based on several working papers which precede Sarris et. al. (2011).

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A recent review of policy options (Byerlee et al., 2006) highlighted the difficulties that many governments face in disengaging from direct interventions, such as stabilization stocks, or discretionary measures such as export bans, but also highlighted the opportunities of using innovative organized market-based instruments. Indeed the proliferation of international risk management instruments, such as futures and options for basic food commodities, may present opportunities for managing the risks that LIFDCs face.

The purpose of this chapter is to explore a potentially successful way in which vulnerable countries can manage some of these risks, in particular those arising from unpredictable behaviour of import prices for staple food commodities. We consider wheat imports of several of the major LIFDCs, and examine, within a counterfactual scenario, the benefits or losses that would have been incurred had they combined their cash imports with simple and transparent hedging strategies based on futures and options. The assessment is made in terms of changes in the variance of unpredictable foreign exchange costs for cereal imports, over a past period of time which includes the 2006-08 high price episode.

Background

There is scant literature on the use of risk management tools to hedge against import instability. An early paper by Faruqee et al. (1997) explored hedging Pakistan's wheat imports with futures. The analysis was based on data for one year only, which opens it to the criticism that the positive results (which favoured the use of futures) could have depended on the specificity of the particular year, or the particular import pattern of that country. Furthermore, Faruqee et al. (1997) explored only one particular hedging rule. A volume edited by Claessens & (eds.) discussed a number of issues relevant to this work. More recently, Dana et al. (2006) examined the issue of hedging maize imports for Malawi and Zambia using futures and options, and showed that hedging led to a small cost reduction in maize imports.

Food imports take place under a variety of institutional arrangements in developing countries. A study on the structure of food trade in developing countries (Gurkan et al., 2003) notes that while in some LIFDCs state institutions still play a very important role in the export of basic foods, food imports have been mostly privatized in recent years. State agencies mostly operate alongside with private importers.

A public sector food importer, namely a manager of a food importing or a relevant food regulatory agency, each year faces the problem of determining the requirements that the country will need to satisfy the various domestic policy objectives, such as domestic price stability, satisfaction of minimum amount of supplies, demands to keep prices at high levels to satisfy farmers, or low to satisfy consumers and others relevant to domestic welfare. Once domestic requirements have been estimated, the problem is how to fulfil them, namely through imports, or by reductions in publicly held stocks, if stock holding is part of the agency's activities. A related problem is the risk of non-fulfilment of the estimated requirements which may result in domestic social problems and food insecurity. The third problem of such an agent is how to minimize the overall cost of fulfilling import requirements, given uncertainties in international prices and international freight rates, and to manage the risks of unanticipated cost overruns. Finally, but not least, the agent must finance the transaction, either through own resources, or some financing mechanisms.

The problems of private import agents are not much different from those of public agents. A private importer must assess with a significant time lag the domestic production situation as well as the potential demand, just like a public agent, and must plan to order import supplies so as to make a profit by selling in the domestic market. As far as unpredictability of domestic production, international prices and domestic demand are concerned, the private importer faces risks similar to those of the public agent. Moreover s(he) faces an additional risk, namely that of unpredictable government policies that may change the conditions faced when the product must be sold domestically. During the recent food price spike of 2006-08, surveys documented the adoption of many short-term policies in response to high global prices of staple foods, which created considerable additional risks for private agents (Demeke et al., 2011). Furthermore, the private agent may be more credit and finance-constrained than the public agent. In fact the study by Gurkan et al. (2003) indicated that the most important problem of private traders in LIFDCs is the availability of import trade finance.

Given the focus of this chapter on hedging strategies, we will not be concerned with the particular institutional character of the agent that imports. Rather, we will refer to an "agent" as the institution, public or private, that does both the actual importing as well as the hedging without specifying the institutional arrangements in the importing country. The assumption is that such an agent will need to plan for imports, in physical or financial terms, ahead of the actual time when imports need to be ordered.

Under the institutional arrangements currently in place in most countries, it is unrealistic to imagine that one single agent would manage all imports. However, the analysis that follows applies to any agent that accounts for a fixed share of the total imports, whether it operates on a private or public basis. While it is clear that there will be no agent that imports a fixed share of the total amount for any country unless there is a monopoly on imports, the fixed share assumption is adopted both because the market information requirements and actions of both private and public agents are the same, and because data for the empirical *ex post* simulations are available only for total commodity imports. Nevertheless, the analysis presented also holds for an agent that would have imported consistently only a "unit" of imports. In any case, the objective is to explore whether hedging with futures and/or options offers advantages over simply importing on the spot market.

Theoretical framework

Consider again the above mentioned agent who needs to plan imports of some basic food for a LIFDC. The present analysis focuses on wheat, which is a widely traded cereal,[3] characterized by well established cash, futures and options markets, and is imported by many LIFDCs[4]. The problem posed is the following: In the course of a year, the agent will need to import certain amounts of wheat for delivery to the country's border in a given month. We shall assume that in any given month the agent has imperfect information on the amounts to be imported several months ahead. In most countries total import requirements will be broadly known some time in advance by traders and other market participants, as domestic production conditions normally become clear several months before the onset of marketing. However, we consider the case in which future import requirements are uncertain.

3 The analysis is extended to maize in Sarris et al. (2011).

4 Most countries in this group do in fact import more than just wheat and maize: rice, other cereals, as well as other staples are also common import items. While some short-term substitution may take place between the various foods imported - an issue on which we have no information - we will examine wheat imports only and separately, assuming implicitly that hedging would not affect the short-term import demand of wheat. Exploring the possibility that risk management affects the volumes of food imports is beyond the objectives of this chapter.

In order to simplify the theory behind the hedging rules, assume initially that the agent estimates that at time 1, which is some months ahead of the present time, s(he) will need to import m_1^e units of wheat. The superscript e denotes that this amount is the current expectation of import needs at time 1, conditioned on information available at time 0. The price the agent will pay when ordering m_1^e at time 1 will be denoted as p_1. Define the following variables:

1. f_0 is the futures price of the commodity observed in a relevant organized commodity market in the current period (denoted by a subscript 0) for the futures contract expiring at, or nearest after, period 1, at which the actual order for imports is placed;
2. f_1 is the price of the same futures contract at time 1;
3. x is the amount of futures contracts (in units of the quantity of the commodity) purchased at the current period;
4. z is the amount of call options contracts purchased also at the current period. The call option contract is written on the same underlying futures contract expiring at or soonest after period 1, and stipulates that if the futures price f_1 at time 1 is higher than a strike price s, determined at the time of the purchase of the option, then the owner of the call option can "exercise" the option, and receive the difference $f_1 - s$ between the futures price at period 1 and the strike price s.
5. The price of the option in the current period is denoted by r_0, whereas the profit from the option in period 1 is denoted by π_1. This profit will be equal to the difference $f_1 - s$ if the option is exercised, and zero otherwise. The profit of the option can be written succinctly as $\pi_1 = (f_1 - s)l$, where l=1 if $f_1 \geq s$ and $l = 0$ if $f_1 < s$.

Given the above definitions, the foreign exchange cost to the agent at time 1 can be written as follows:

$$M_1 = p_1 m_1 - (f_1 - f_0)x - (\pi_1 - r_0)z = p_1(m_1^e + \mu_1) - (f_1 - f_0)x - (\pi_1 - r_0)z \tag{1}$$

where μ_1 denotes the zero mean prediction error of the current estimate of import needs. It shall be postulated that the agent wishes to minimize the conditional variance of M_1, conditioned on information Ω_0 available at the current time 0. This is written as

$$W = \min E\{Var[M_1]|\Omega_0\} \equiv Var_0[M_1] \tag{2}$$

where the second identity above defines the notation for the conditional variance[5]. The first order conditions for this problem can be written as follows[6]:

$$E\left\{\frac{\partial Var_0[M_1]}{\partial x}(f_1 - f_0)\right\} = 0 \tag{3}$$

$$E\left\{\frac{\partial Var_0[M_1]}{\partial z}(\pi_1 - r_0)\right\} = 0 \tag{4}$$

To characterize the solution, it is necessary to make assumptions about the relationship between the cash and the futures price. Following Benninga et al. (1984), the cash price is written as a linear function of the nearest futures price

$$p_1 = \alpha + \beta f_1 + \theta_1 \tag{5}$$

where θ_1 (the basis risk at time 1) is independently distributed from f_1 and has zero mean.

[5] In principle, it would be possible to consider a more general concave utility function $u(.)$ over M; but this would complicate matters without adding much to the argument. Our objective in this chapter is to discuss how to reduce the unpredictability of imports; choosing the variance helps focus the argument on the existence of benefits from hedging, rather than on the shape of the utility function, which was the object of several other contributions, such as Benninga et al. (1984) and Lence & Hayes (1994). Analyses using more general utility functions include Lapan et al. (1991) and Sakong et al. (1993).

[6] The second order conditions hold because of the convexity of M.

The problem will be solved under the additional assumption that the current futures price is unbiased, namely that the currently observed futures price f_0 is the (conditional) expected value of f_1, and that the options are fairly priced, in the sense that the current option price r is the expected value of π_1. Finally, it is assumed for the time being that the eventual adjustment to imports μ_1 is only a function of domestic revisions to requirements, owing to improved domestic information, and is not correlated with p_1, which is the prevailing international price at time 1. In principle, this is not entirely correct, as at time 1, when the order is placed, world prices may call for additional adjustment of planned imports. For instance, prices may be high enough to require a reduction regardless of the conditions prevailing in the domestic market. Such adjustments are usually the consequence of financial constraints or considerations; they will initially be assumed away for simplicity. In other words *ex ante* adjustments of imports to expected world prices are incorporated into m_1^e and subsequent last minute adjustments are ignored for the time being. We will discuss such *ex post* adjustments later.

Given the above assumptions, we can write the conditional variance as a quadratic expression in x and z. The minimization of this expression using straightforward algebra yields the well known results $x = \beta m_1^e$ and $z = 0$ (Benninga et al., 1984; Rolfo, 1980).

It could be hypothesized that the importer only has call options available as a hedging instrument, instead of futures, and explore the optimal hedging rule for this case. This is a possible scenario in the real world, as over the counter (OTC) options are available for commodity traders in absence of organized futures markets. It can then be easily derived from the above equations, that in such a case the optimal hedge ratio with call options only, is equal to the following expression;

$$z = \beta m_1^e \frac{Cov(f_1, \pi_1)}{Var(\pi_1)} \tag{6}$$

As the covariance of f_1 and π_1 as well as the variance π_1 are conditional on values of f_1 greater than s (the strike price), it can be easily shown that the covariance in the numerator in (6) is equal to the variance ofπ_1. Hence the coefficient that multiplies the optimal futures-only hedge ratio, βm_1^e, above is equal to 1. When only options are allowed, the optimal options hedge ratio is equal to the optimal futures hedge ratio, and is equal to β times the expected import level. Note that these results do not depend on the fact that the *ex post* imports m_1 is stochastic, as the welfare criterion is equal to the variance of M_1. If the welfare criterion was a concave utility of M_1, then the resulting optimal policy would be a combination of futures and options (Sakong et al., 1993). Notice also that the results do not depend on the magnitude or the variance of the basis at time 1, namely parameter α and the variance of θ_1 in our notation.

The above results pertain to the case in which the stated objective of the agent is to minimize the unanticipated two-sided variability of the import bills. It may, however, be the case that the agent is interested in minimizing only the unanticipated positive deviations of the import bills, as these deviations are the most detrimental from a food security standpoint as well as a cost perspective. We can deal with this problem by assuming a narrower objective, namely that the agent wishes to minimize the truncated variance of the unanticipated import bill. Given the assumptions made about the efficiency of the futures and options markets, and if it is assumed that the truncation level is the mean of the underlying distribution of imports, it can be shown using the formulas in Greene (2000) that both the truncated mean and the truncated variance of M_1 are functions only of the conditional variance of M_1. Hence, if the assumed objective of the agent is to minimize the truncated mean of the import bill deviations, it can be shown that this objective corresponds to the minimization of the variance of M_1. The same point holds if the objective of the agent is to minimize only the truncated variance of M.

Assume now that there are *ex post* adjustments to the estimated import requirements m_1^e. To simplify the discussion, assume a simple form of linear *ex post* import adjustment as follows.

$$m_1 = m_1^e - e\left(p_1 - p_1^e\right) + \mu_1 \tag{7}$$

Compared with the simpler formula for the import rule indicated in (6), this incorporates adjustments following from deviations of the *ex post* price p_1 from the *ex ante* expected price p_1^e, by introducing a parameter e. Minimization of the conditional variance of the food import bill M_1, through long but straightforward algebra, implies that the optimal futures hedge is smaller than the previously estimated one, while now the optimal amount of options hedge is nonzero. The relevant formulas are the following.

$$x = \beta\left(m_1^e - ep_1^e\right) - e\beta^2 \frac{A-B}{Var f_1 - Cov\left(f_1, \pi_1\right)} \tag{8}$$

$$z = -e\beta^2 \frac{-ACov(f_1, \pi_1) + BVar f_1}{Var\pi_1\left[Var f_1 - Cov\left(f_1, \pi_1\right)\right]} \tag{9}$$

where

$$A = E_0(f_1 - f_0)^3 \tag{10}$$

$$B = E_0\left[(f_1 - f_0)^2(\pi_1 - r_0)\right] \tag{11}$$

For an "at the money option", namely when the strike price s is equal to the expected futures price f_0, it can be seen that $A = B$. For an "out of the money" call option where $s > f_0$, then $A > B$. As the denominators in (8) and (9) are positive, the conclusion is that when there are financial constraints or other considerations which dictate *ex post* adjustments of import plans, then the optimal futures hedging rule suggests an amount of futures purchases smaller than the amount dictated by the simple hedge ratio β, and at the same time the purchase of some call options.

The above discussion indicates that even with the simple variance criterion, the optimal hedge can involve a combination of futures and options. Earlier research concluded that a mixed hedging strategy was optimal under two conditions, namely when there is uncertainty in the *ex post* imports; and when the objective function involves a concave utility (Sakong et al., 1993). We have shown that a combined rule is also optimal when there are budget constraints that may imply *ex post* adjustments. Such conditions are relevant in LIFDCs that face constraints in the availability of foreign exchange. In practice, however, it is very difficult, if not impossible to estimate the *ex post* adjustment parameters e: even for a monopolistic import agent, it is difficult to obtain information on *ex ante* and *ex post* import transactions. Hence in the *ex post* simulations described below in the chapter we will assume that e is equal to zero.

Another possibility is for the importer to buy at time t, k months ahead of when delivery is required, and store the commodity until time $t+k$. An agent following such a strategy would need to decide whether to store the physical commodity in the country of destination or in the country of origin. Either way, s(he) will incur storage cost, and deal with price

Table 19.1: Wheat import profiles of selected LIFDCs (000 tonnes)

	Average imports	% Share in LIFDC imports	% Share in world imports	% Share in consumption		Average cereal imports	% Share in cereal imports
	1980–08	1980–08	1980–08	1980–90	1991–08	1980–08	1980–08
Bangladesh	1 622	3.9	1.6	59.5	57.7	2 285	71
China, Mainland	6 772	16.3	6.6	12.5	3.7	8 813	76.8
Egypt	6 839	16.4	6.7	73.2	53.2	9 756	70.1
India	1 122	2.7	1.1	2.5	1.7	1 359	82.6
Indonesia	3 137	7.5	3.1	101.2	103.7	4 844	64.8
Mozambique	210	0.5	0.2	95.1	102.5	589	35.6
Nicaragua	98	0.2	0.1	105.2	92.8	220	44.3
Pakistan	1 345	3.2	1.3	6.3	8.5	1 368	98.3
Philippines	1 956	4.7	1.9	103.4	100.2	2 963	66
Sudan	772	1.9	0.8	70.3	68.4	960	80.4
Tanzania, Un. Rep.	177	0.4	0.2	44.8	85.4	370	47.9
Total of Above	24 049	57.8	23.4	33 527			
Total LIFDC	41 638	100	40.5	62 846			
World	102 786	220 716					

uncertainty at the time of the sale. Futures prices reflect the market-determined cost of storage of a commodity between the time the futures is bought and the later physical transaction time (periods t and $t+k$ in our discussion), albeit this cost can be negative because of backwardation[7]. Hence buying futures can be considered as an alternative to inventory holding, albeit the market-determined cost of storage in Chicago may have little to do with the cost of storage - and any implicit backwardation - in local markets. If the agent is well aware of the domestic storage situation, and thinks that the domestic price of storage (including any convenience yield) is lower than the market price of storage as determined in the hedging market, then it may indeed be appropriate for her/him to order the commodity now at time t, and then store it in the country of destination and sell it later. However, there is no information available on this issue, and we do not pursue it further in this chapter.

Empirical implementation

The empirical analysis presented here is based on monthly import data; therefore the choice of the countries included in our sample was restricted by the availability of information at this frequency over a reasonably long time span. Out of the LIFDCs group, we selected eleven countries that have engaged in large wheat imports over the past 25 years (Table 19.1).

The sample of importers accounted for 58 percent of total LIFDCs wheat imports in the period 1980-2008 and for 23 percent of world imports of this product. It is worth noting

7 See Considine and Larson (2001) on risk premiums and backwardation.

the high share of wheat in the countries' total cereal imports, the percentages reported in the last column, indicate that wheat is the most important cereal imported. Moreover, with the exception of large countries like China (Mainland), India and Pakistan, wheat imports account for a large share of the total wheat consumed domestically.

Different profiles of countries imply different problems associated with cereal imports. For example, large countries could experience deficits and surpluses in different areas, and this may prompt imports as well as exports at different times in the year, if the domestic market cannot arbitrage appropriately, or if it is cheaper to buy or sell abroad; this behaviour is observed in some of the countries included in our sample. Occasionally, importing countries may face conditions that would make regular hedging strategies difficult to implement. Landlocked countries, for instance, may face significantly larger basis risk, given their isolation and the importance of transport costs. The variance of international prices for landlocked countries may therefore constitute a smaller risk compared with the variance of the basis between the international purchasing centre and their import point. These caveats should be kept in mind when interpreting the results.

Most of the actual wheat imports by the countries included in our sample are obtained and priced on the basis of export prices in major exporting countries, such as the United States of America, Australia and Argentina. Sarris et al. (2006) showed, however, that export prices in these markets are strongly correlated, and also that the import unit values of the selected importing countries are significantly correlated to the reference export prices. Furthermore, it was shown that the various reference prices are closely related among each other. This implies that it is possible to use one of the international reference prices for wheat as a proxy for the import price (minus transport cost) of the importing country. We chose US Gulf prices to represent international reference prices for imports of wheat. Similarly we consider the Chicago Mercantile Exchange (CME) as the major hedging market for orders made with reference to the Gulf prices.

Consider first the problem of hedging the price risk for an amount of wheat equal to the hedge ratio times the known amount that will be imported some months ahead. As shown, *ex post* uncertainty about the level of imports does not affect hedging rules when the objective is to minimize the conditional variance of import bills. Hence, we shall restrict the empirical analysis to the case when the imports are known or have been estimated precisely *ex ante*. Adding uncertainty to imports does not change the overall results of the simulations.

The hedging rules analysed here imply transactions through futures or options. In terms of data, we employed firstly the actual imports of wheat for all LIFDCs on an annual basis (both calendar year as well as July-June) from the 1960s. Secondly, we used International Wheat Council (IWC) and FAO data on monthly wheat imports for LIFDCs by origin of imports, since 1995. Given this monthly information, for the years in which monthly import data are not available we assumed that the monthly import pattern is the same as the average pattern of the years for which monthly observations are available. Thirdly, futures and options daily data were obtained from the CME from 1986 to 2008. We assumed that all import transactions are done at Gulf prices. This is certainly an approximation, as not all transactions are undertaken on this basis; but it is a reasonable assumption, given that all major export market prices are related to these prices. The simulations involve buying futures or call options at a given point in time, ahead of the physical wheat contracting, and selling them later, namely when the actual physical transaction for wheat imports is concluded.

The actions of the agent will aim at insuring the price risk of the physical purchases. It will be assumed that the cash orders for grains imported in a given month are placed one month in advance. This appears reasonable in light of the norms of the trade, and implies that the price at which wheat imports will be valued and eventually paid are those of one month ahead of the actual physical arrivals at the border.

The hedging rules are defined by the following parameters:

1. the day of the year at which the contract (futures or option) is bought;
2. the contract to be purchased (namely the month for which a futures or option contract is purchased);
3. the amount to be purchased under the contract;
4. for options, the strike price at which the call option is purchased.

We will simulate the following two sets of rules (strategies).

Rule 1. Hedging only with futures contracts Under this set of rules, which are similar to those simulated by Faruqee et al. (1997), we assume that the agent buys futures *k* months in advance of the date when s(he) needs to contract the actual delivery. The contract date is assumed to be one month before the needed physical delivery of import, as per the seasonal import needs, which, as indicated above, is assumed to be known. In other words, suppose that according to the requirements, the importing agent needs to physically import 100 000 tonnes of wheat in December. The actual contract for physical delivery in December will have to be placed in November, and this implies that the price at which the transaction and the payment will be made is the November price. Therefore, the need is for hedging the November transaction and payment. If we assume that $k=4$, then the agent will buy futures contracts for amounts totalling $\beta\times100\ 000$ tonnes in July (namely in the $11-4=7^{\text{th}}$ month of the year). The futures contract at which the futures transaction will be made will be the closest available after the date in which the purchase is needed. In the above example, the actual forecasted transaction is in November, and the nearest traded futures is the December contract, hence the agent will buy December wheat futures in July, and sell them in November.

In the simulations it is assumed that the agent can buy futures contracts for the exact amount of the product that s(he) needs to hedge. This is an approximation, as the actual futures contracts are available only for fixed lump amounts (for instance the standard CME wheat futures contract is for 5 000 bushels[8] or about 130 tonnes), but it is possible to obtain futures for whatever amount the agent may wish through brokers and traders, for a small extra fee.

Once the month of purchase is determined, for the simulations we still need an assumption on the exact days at which the agent will purchase and, later, sell the contracts; this was assumed to be the closest day to the middle of the month[9]. The same strategy is applied month after month. Concerning costs, it was assumed that buying or selling futures implies a USD 0.15 per tonne commission, as in Faruqee et al. (1997); and that each futures transaction requires a deposit margin equivalent of 5 percent of its value. We also assumed that there is an opportunity cost on this margin, valued at a rate equal to the United States of America base interest rate, which changes every month (published by the United States of America Federal Reserve). This cost is calculated over the period of the hedge.

8 In the CME one could purchase also mini-wheat and mini-corn contract which trade in 1 000 bushel units.

9 The sensitivity of results to this assumption was checked by repeating the simulations under the assumption that transactions would take place at the beginning and at the end of the month. The results were virtually unchanged; hence we decided to report only those for the mid-month transactions.

Rule 2. Hedging with options The conditions stated above for futures, concerning the dates at which the contracts are bought and the dates of expiration, also hold for the simulations with call options. The only difference is that in this case also the strike price has to be determined. The strike price is parameterized as $(1+\alpha)p^f_{t,t+k}$, where $p^f_{t,t+k}$ denotes the futures price observed in month t for the contract expiring at, or in the nearest month after, the period $t+k$, when the actual transaction will be made. The parameter α is the proportion above $p^f_{t,t+k}$ for which insurance is sought. Hence if $\alpha = 0.1$, the (out-of-the-money) call option bought implies that if the future price observed at the time of ordering is above the strike price - which as per the option specification is 1.1 times the future price observed at the time of purchase of the option - then the difference between the actual higher futures market price and this strike price will be paid to the buyer of the option, namely the agent. Based on industry information, we assume a transactions cost for buying the call option equal to 4.5 percent of the option price.

An example is in order. Suppose that in a given trading day in the seventh month of the year, namely 15 July, the agent purchases a call option with $\alpha = 0.1$ and $k = 4$. This means that the call option expires in November (month 7+4), when the contract will have be made for the physical wheat shipment to be delivered in December. Suppose that on 15 July, the December future is quoted at USD 90.9 per tonne[10]. With $\alpha = 0.1$ the desired strike price at which the call option will be bought is P_s = USD 100 = (1.1×90.9). As options are not available for all strike prices, the strike price at which the call option is bought is the nearest to the desired price of USD 100 among those quoted. Assume that this is USD 98.0 and that the cost of buying this call is PR= USD 12.0. The calculation of the gain from the option purchase examines the December future price in mid-November; as mentioned we consider the settlement price on 15 November or the nearest trading day. Suppose that this price has moved upward beyond expectations, to P_{NF} = USD 120. In this case the option will be exercised, and the net gain, taking into account the transactions cost, will be $N = (120-98)-12-0.045\times 12$ =USD 9.46. Suppose now that price growth expectations have not fully materialized, so that the December future on 15 November has only reached $P_{NF} = 95$. In this case the option will not be exercised, and the net loss accounted for will be $N = -12-0.045\times 12$ = USD -12.54.

Given that the objective of the hedging exercise is to reduce the conditional variance of the import bills, an *ex post* measure of success of the hedging strategy, as per the theory presented earlier, is the variance of the unpredictable changes in the values of imports with and without hedging. For each period we first compute for each t the unexpected change in import cost

$$M_{t+k} - E(M_{t+k,t}) = \left\{p_{t+k}m_{t+k} - E(p_{t+k,t})m^e_{t+k}\right\} \tag{12}$$

and then compute the variance (or standard deviation) of the changes in (12) over a given historical period. When the same imports are hedged with futures, the unpredictable change in the import cost is equal to:

$$M_{t+k} - E(M_{t+k,t}) = \left[p_{t+k}m_{t+k} - E(p_{t+k,t})m^e_{t+k}\right] - \beta\left(f_{t+k} - f_t - \tau_f f_t - g_{t,t+k}f_t\right)m^e_{t+k} \tag{13}$$

where τ_f denotes the unit transactions cost of buying a futures contract, g is the margin requirement (assumed to be 5 percent) and $i_{t,t+k}$denotes the interest charge on the margin over the period t to $t+k$. Note that we neglect possible margin calls during the period of

10 Prices are actually quoted in cents per bushel, but we refer to dollars per tonnes for simplicity.

holding the futures contracts. When prices fall in the course of holding a long futures contract, the agent will have to post additional margin, and this may create liquidity and financing problems with the agent. In the simulations we ignore this aspect of futures hedging, albeit for cash constrained LIFDCs it may be important.

Finally, when the same imports are hedged only with call options, the unpredictable change in the import cost is equal to:

$$M_{t+k} - E(M_{t+k,t}) = \left[p_{t+k}m_{t+k} - E(p_{t+k,t})m^e_{t+k}\right] - \beta(\pi_{t+k} - r_t - \tau_o r_t)m^e_{t+k} \quad (14)$$

where π_{t+k} is the actual realized profit on the option contract (namely equal to $f_{t+k} - s$, if this quantity is positive at time $t+k$, and zero otherwise); and τ_o denotes the unit transactions cost of buying a call option contract. As discussed earlier, the *ex ante* uncertainty about the value of the eventual physical imports does not affect the hedging rules. Hence for the simulations the expected values above will be set equal to the actual observed values of imports.

In order to implement (12)-(14) we need to estimate the conditional expectation of the future cash price. Under the assumption (5), the conditional expectation at time t of the cash price at time $t+k$ is a linear function of the conditional expectation of the nearest futures price at time $t+k$. Under the assumption that futures markets are unbiased, this latter expectation is equal to the price of the futures contract that expires at or near time $t+k$, observed at time t. Hence we can use the following expression for estimating the conditional expectation in equations (12)-(14):

$$E(p_{t+k,k}) = \alpha + \beta f^{t+k}_t \quad (15)$$

where f^{t+k}_t is the price at time t of the futures contract expiring at or nearest after period $t+k$ and α, β are parameters to be estimated empirically.

The simulation exercise compares the standard deviations of the normalized expressions in (12)-(14). The normalization is obtained by dividing the expression in (12)-(14) by the average unhedged import bill for the period under investigation, namely the average of the magnitudes$p_t m_t$. This normalization is the same in the case of unhedged and hedged imports, so that whatever difference is estimated in the variability measures of the above expressions are owing to the application of the futures and options hedges, and not the denominator. It should be underlined that the monthly import values are approximate and indicative import bills for grains. As discussed above, they are computed on the assumption that the price paid by a country when importing from the United States of America or any of the other main exporters is the Gulf price.[11]

Before undertaking the simulations, we analysed whether the CME futures prices can be employed as expectations of the reference cash prices, as per equation (15); and verifies that

[11] This is an approximation, as there may be significant transport and other country specific transactions related cost differentials between the Gulf prices and the border prices in the country. But as data on actual transactions and monthly c.i.f. prices are unavailable, it is meant to provide at least some indicative figure. If the transport costs and any other country specific costs are independent of the world market price, which we assume is represented by the Gulf price, then all the previous discussion remains intact, but the amount of the actual import bill that is hedged in our analysis would be a fraction, different for each country, of the total actual import bill. Our results and the analysis do not take into consideration these latter costs, whose variability is in fact assumed to be orthogonal to world prices. However, this may not be the case in periods of price spikes, depending on the source of the spike. In point of fact, during the recent price boom of 2007-08, the Baltic freight rate index, which is a representative index of bulk freight rates, has been highly correlated with commodity prices, but it is not clear whether this is a recent and only temporary phenomenon.

CME futures prices - and hence those of the related options - are indeed effective reference prices for hedging grains imports of the selected LIFDCs.

The bulk of wheat imports into the countries included in our sample is obtained from the United States of America, Australia and Argentina. Hence we considered the US Gulf price for hard winter ordinary No. 2 wheat, and the monthly export unit values for Australia and Argentina as world import reference prices for wheat[12]. Time series analysis involving co-integration tests, between the three world wheat reference prices revealed that they move closely together Sarris et al. (2006). Hence we could safely choose one of the three world wheat reference price as the single representative price for wheat imports, and we choose the US Gulf price.

Moreover, we studied the relationship between the Gulf prices and CME spot prices in order to compute hedge ratios and to determine the functional form for price expectations. As futures are defined only for certain months, the CME price that was considered as the corresponding reference futures price for the Gulf market was assumed to be the one for the nearest futures contract.

In order to study the basis risk of the Gulf prices, time series price relations were analysed econometrically. These results indicate that there is a near perfect transmission of long-run price signals between the Chicago futures market and the average Gulf import prices relevant for the selected countries; and this allows hypothesizing that the Chicago futures market is viable to hedge import price risks. However, in the short-run, the relationship between reference export prices and CME prices may not be perfect.

The definition of an optimal hedging dynamic strategy based on the dynamic relation between the country-level import price and the CME prices is beyond the scope of this chapter. As, however, the steady-state relationship in (5) is econometrically robust, deviations in the optimal strategy from one based on the long-run relationship are expected to be small. Moreover, if the unanticipated price variance is reduced by hedging with the static rules simulated in this chapter - as the empirical results show - then it is to be expected that more complex rules will reduce it even further. Thus, in the simulations described below, the assumption is made that the value of the hedging parameter β in equation (15) is equal to the value of the long-run transmission parameter.

Results of hedging strategies with futures and options

Statistics of the measures in (12)-(14) are presented firstly with reference to one unit of imports, in order to show separately the contributions of prices to the overall unpredictability of the import bills. Table 19.2 exhibits the relevant statistics in the form of standard deviations of the relevant percent changes.

Hedging with futures reduces considerably the unexpected variability of import prices for grains, and for all periods simulated. The reductions are substantial, and as large as 72 percent in the 2006-08 period. Standard deviations of futures hedging (the middle set of rows) are homogeneous across the different values of k, as the hedge ratio β is close to one, as seen in Table 19.2. Hence, as per formula (15), the expression (13) reduces largely to the difference between the cash and futures price at time t, whose size is not significantly affected by changes in the *ex ante* futures price which varies with k.

Concerning import bills, Table 19.3 indicates the unanticipated normalized standard deviations of monthly wheat import bill changes with and without hedging with futures only,

12 Data for these three prices are reported in the IMF International Financial Statistics.

Table 19.2: Average unanticipated prediction errors, coefficients of variation and standard deviations of percentage prediction errors of cash and futures prices for wheat on CME over 1985-2008

		1985-7: 2005-12	2006-1: 2008-12	1985-7: 2008-12
Gulf Price (USD/mt)		143.3	257.6	157.6
$(P_t\text{-}E_{t-k}(P_t)/P_t)$ (percent)	k=2	-1.1	1.5	-0.7
	k=4	-1.2	1.6	-0.9
	k=6	-1	4.2	-0.3
$[(F_t\text{-}F_{t-k})/P_t]$ (percent)	k=2	-0.3	0.9	-0.2
	k=4	-1.3	1	-1
	k=6	-1.9	3.5	-1.2
CV of Gulf price (percent)		18.9	30.3	33.7
CV of CBOT near futures price		17.1	32.2	31.8
Stdev of $[(P_t\text{-}E_{t-k}(P_t))/P_t]$ (percent)	k=2	8.3	16.1	9.6
	k=4	10.9	22.6	13
	k=6	13.3	26	15.6
Stdev of $[(F_t\text{-}F_{t-k})/P_t]$ (percent)	k=2	8	16.2	9.4
	k=4	10.4	22.6	12.6
	k=6	12.9	25.6	15.2

for the same periods indicated in the previous table. Table 19.4 reports the same variables for hedging strategies exclusively based on at the money call options.

Several observations are in order. First the ability of a simple linear formula such (15) to predict the subsequent actual cash price performs well on average in "normal periods, even some months in advance. Notice that the average percent forecast errors during the period 1985 to 2005 for all values of were smaller than 1.2 percent. During a period of high prices, namely the episode of 2006-8, the ability of (15) to predict the eventual cash price of wheat deteriorated only slightly for $k = 2$ and $k = 4$, but more so for $k = 6$. This performance is mirrored in the ability of the futures price to forecast the subsequent futures price. The forecast statistics for average unpredictability of the futures prices are quite similar to those of the cash market statistics.

Turning to the variability of *ex ante* predictions, the last two sets of rows in Table 19.2 exhibit the standard deviation of the percent forecast errors of the expected cash and the futures prices. It can be seen that these are considerable and increase with the length of time before the actual purchase, as would be expected.

For instance for $k = 2$, namely for two months advance, the average percent standard deviation for the cash and futures price of wheat over the period 1985-2005 is around 8 percent. As the 95 percent confidence interval for predictions under normality is about two standard deviations, these numbers imply that even within 2 months before actual ordering, the price uncertainty is in the vicinity of 16 percent of the currently observed cash price. This is considerable and basically indicates the variability and unpredictability in these markets, even for short planning periods.

For $k = 4$ the same standard deviations increase to 10-11 percent, while for $k = 6$ the numbers jump to about 13 percent. Notice, however, that during the food price increase period of 2006-08, the unpredictability increased considerably, with the standard deviations of the prediction errors in both cash and futures markets increasing by 100 percent or more in some cases from the averages of the more normal twenty year period of 1985-2005.

Turning to the unpredictability of the import bills, out of the LIFDCs group, eleven countries were selected that have been wheat importers over the past 25 years, based on availability of monthly import data. The sample of importers accounted for 58 percent of total LIFDCs wheat imports in the period 1980-2008 and for 23 percent of world imports of this product.

Table 19.3 indicates the unanticipated normalized standard deviations of monthly wheat import bill changes (based on (12)) with and without hedging with futures. Table 19.4 repeats the exercise when hedging is done only with at the money options. The results cover as in the previous tables two periods, namely the period July 1985 to December 2005, namely before the grains price spike, the spike period January 2006 to December 2008 and the two periods combined.

The results in Table 19.3 indicate that for all the countries analysed there seems to be substantial reductions in import bill unpredictability for all periods and for all values of k, when imports are hedged with futures. The only exception seems to be India for which the unpredictability with futures and for $k = 4$ seems to have slightly increased. This seems an oddity and is not owing to the behaviour of the cash or futures prices, as these affect all countries in the same fashion. The phenomenon may be owing to the particular pattern of imports of India during the high price period. In fact wheat imports of India during 2008, declined to about 10 percent of the average wheat imports of the previous two years. Furthermore, India seems to have exhibited in the past a marked seasonal pattern of wheat imports, with low imports early in the calendar year, peaking in the middle of the year, and then declining during the rest of the year. The reductions in unpredictability of import bills seem to be larger during the high price period of 2006-08 compared with the earlier period for all countries and values of k, with the notable exceptions of China (Mainland) and India.

Table 19.4 indicates that if hedging was done with options only, the unpredictability of wheat import bills would have also decreased considerably for all countries and periods, again with the only exception being India for the high price period and for $k = 4$. The percent reductions in unpredictability are smaller with options (as expected from theory) in all cases. The reductions seem to be larger for the period of price turmoil for all countries except China (Mainland) and India.

Concluding remarks and implications for import strategies

The simulated reductions in unpredictability are quite substantial. An important result is that reductions in unpredictability were quite significant during the recent high price period and larger than in normal times. This suggests that during periods of high prices and volatility, considerable advantage in import bill management can be obtained by the use of organized futures and options markets. As organized futures and options markets in the CME seem to be quite efficient, no agent can be expected to make profits in the long-run from applying hedging rules of the types simulated here. Hence the motivating force for hedging can

Table 19.3: Unanticipated normalized standard deviations of monthly wheat import bill changes with and without hedging with futures and at the money options

	Unanticipated normalized standard deviation of monthly import bill changes without hedging			Unanticipated normalized standard deviation of monthly import bill changes, when hedged with at the money options only			Percent difference from unhedged		
	1985-7:	2006-1:	1985-7:	1985-7:	2006-1:	1985-7:	1985-7:	2006-1:	1985-7:
	2005-12	2008-12	2008-12	2005-12	2008-12	2008-12	2005-12	2008-12	2008-12
		2 = k			2 = k			2 = k	
Bangladesh	10	21.1	16.4	6	5.9	6.2	-40.5	-72.1	-61.8
China	11.1	20.3	11.9	5.2	11.2	5.5	-53.3	-44.9	-53.3
Egypt	9.4	21.5	15.5	5.3	6	5.8	-43.1	-72	-62.6
India	24.3	27.7	41.3	14	25.7	35.4	-42.3	-7.2	-14.4
Indonesia	10.9	18.7	17	6.8	6.8	7.1	-37.8	-63.8	-58.5
Mozambique	9.4	15	14.9	6.9	7.9	8.4	-26.1	-47.2	-43.4
Nicaragua	13.8	23.6	18.8	7	8.1	7.7	-49.2	-65.6	-58.9
Pakistan	14.9	48.2	30.6	5.9	4.8	5.8	-60.1	-90	-81.2
Philippines	10	18.4	14.7	6.1	6.6	6.6	-39.2	-64.8	-54.9
Sudan	10.3	19.1	16	6.8	6.7	7.2	-34.5	-64.8	-54.9
Tanzania	11.8	26.8	33.8	9.4	6.9	10.3	-19.9	-74.3	-69.6
		4 = k			4 = k			4 = k	
Bangladesh	14.4	30.3	23.5	5.9	5.9	6.2	-58.7	-80.6	-73.4
China	16	27	17.1	5.2	11.2	5.5	-67.5	-58.5	-67.5
Egypt	12.3	23.1	17.8	5.3	6	5.8	-56.6	-73.9	-67.4
India	30.8	25.1	40.4	14	25.7	35.4	-54.4	2.4	-12.3
Indonesia	14.1	21.9	20.7	6	6.8	7.1	-57.3	-69	-65.9
Mozambique	12.6	22.2	21.5	6.9	7.9	8.4	-44.9	-64.3	-60.7
Nicaragua	21.5	32.8	27.4	7	8.1	7.7	-67.3	-75.3	-71.8
Pakistan	20.9	52.7	35	5.9	4.8	5.8	-71.7	-90.9	-83.6
Philippines	12.8	23.6	19	6.1	6.6	6.6	-52.6	-71.9	-65.2
Sudan	12.8	18.8	17.4	6.8	6.7	7.2	-46.9	-64.2	-58.5
Tanzania	14.3	24.8	31.8	9.4	6.9	10.3	-34	-72.3	-67.6
		6 = k			6 = k			6 = k	
Bangladesh	17	40.9	30.9	5.9	5.9	6.2	-65.1	-85.6	-79.8
China	19.7	35.1	21	5.2	11.2	5.6	-73.5	-68	-73.5
Egypt	14.6	27.6	21.7	5.3	6	5.8	-63.4	-78.2	-73.2
India	34.6	33.6	51.7	14	25.7	35.4	-59.4	-23.5	-31.4
Indonesia	15.8	26.3	25	6	6.8	7.1	-62	-74.3	-71.7
Mozambique	14.3	24.2	24.3	6.9	7.9	8.4	-51.7	-67.3	-65.3
Nicaragua	24.4	55	40.1	7	8.1	7.7	-71.2	-85.3	-80.7
Pakistan	27	63.2	42.7	5.9	4.8	5.7	-78.1	-92.4	-86.6
Philippines	14.9	24.1	21	6.1	6.6	6.6	-59.5	-72.6	-68.5
Sudan	14.8	21.5	20.7	6.8	6.8	7.2	-54.1	-68.4	-65
Tanzania	17.5	30	38.8	9.4	6.9	10.3	-46	-77	-73.5

Table 19.4: Unanticipated normalized standard deviations of monthly wheat import bill changes with at the money options hedging only

	Unanticipated normalized standard deviation of monthly import bill changes without hedging			Unanticipated normalized standard deviation of monthly import bill changes, when hedged with futures only			Percent difference from unhedged		
	1985-7:	2006-1:	1985-7:	1985-7:	2006-1:	1985-7:	1985-7:	2006-1:	1985-7:
	2005-12	2008-12	2008-12	2005-12	2008-12	2008-12	2005-12	2008-12	2008-12
		2 = *k*			2 = *k*			2 = *k*	
Bangladesh	10	21.1	16.4	7.6	12.7	10.7	-24.5	-40	-34.5
China	11.1	20.3	11.9	6.9	13.5	7.4	-37.9	-33.5	-37.9
Egypt	9.4	21.5	15.5	6.4	13.1	10	-31.6	-39.3	-35.9
India	24.3	27.7	41.3	20.7	25.5	37.4	-14.9	-7.8	-9.3
Indonesia	10.9	18.7	17	7.7	11.6	11.2	-29.3	-37.9	-34.5
Mozambique	9.4	15	14.9	8.1	8.1	10.5	-13.3	-45.9	-29.6
Nicaragua	13.8	23.6	18.8	9.5	9.1	9.8	-31.6	-61.3	-47.8
Pakistan	14.9	48.2	30.6	9	29.9	19.4	-39.6	-38	-36.6
Philippines	10	18.4	14.7	7.6	11.6	10.1	-23.2	-36.8	-31.3
Sudan	10.3	19.1	16	8.1	12.1	11	-21.6	-36.9	-31.4
Tanzania	11.8	26.8	33.8	11.6	17	22.7	-2.1	-36.7	-32.9
		4 = *k*			4 = *k*			4 = *k*	
Bangladesh	14.4	30.3	23.5	10.3	15.1	13.4	-28.1	-50.1	-43.1
China	16	27	17.1	9.1	16.1	9.7	-43.3	-40.2	-43.2
Egypt	12.3	23.1	17.8	8.3	10.9	9.8	-32.2	-52.7	-45
India	30.8	25.1	40.4	29.2	26.1	39.6	-5.1	3.9	-2
Indonesia	14.1	21.9	20.7	9.7	10.7	11.4	-30.8	-51.3	-45
Mozambique	12.6	22.2	21.5	10.4	11.2	12.3	-17.5	-49.4	-42.6
Nicaragua	21.5	32.8	27.4	15.4	10.8	14.5	-28.7	-67	-47.3
Pakistan	20.9	52.7	35	14.5	30.2	21.7	-30.6	-42.7	-38.1
Philippines	12.8	23.6	19	9.1	11.7	10.9	-28.7	-50.4	-42.8
Sudan	12.8	18.8	17.4	9.7	9.1	10.2	-23.6	-51.7	-41.4
Tanzania	14.3	24.8	31.8	12.8	14.8	20.3	-10.4	-40.6	-36.3
		6 = *k*			6 = *k*			6 = *k*	
Bangladesh	17	40.9	30.9	12.4	21.1	17.6	-27.5	-48.3	-43
China	19.7	35.1	21	10.8	21.9	11.5	-45.2	-37.6	-45
Egypt	14.6	27.6	21.7	10	12.7	11.6	-31.9	-54	-46.6
India	34.6	33.6	51.7	29.3	28.2	42.4	-15.2	-16.1	-18
Indonesia	15.8	26.3	25	10.5	12.3	12.8	-33.2	53.1	-48.7
Mozambique	14.3	24.2	24.3	11.4	12.1	13.4	-20.5	-49.8	-44.7
Nicaragua	24.4	55	40.1	18.6	26.7	22.9	-24	-51.6	-42.8
Pakistan	27	63.2	42.7	19.8	36.5	27.2	-26.7	-42.2	-36.3
Philippines	14.9	24.1	21	10.5	11.4	11.5	-29.9	-52.9	-45.1
Sudan	14.8	21.5	20.7	11	8.7	10.9	-25.6	-59.2	-47.3
Tanzania	17.5	30	38.8	16.1	16.2	22.5	-7.7	-46	-42

be predictability and improved planning, and not profitability, which would rather be the motivation of private speculators, but not of financial or import planners.

A number of caveats are in order when considering the results of the simulations. Firstly, given the importance of the countries involved in global wheat imports, one may question whether their involvement in the CME would influence the price determination process in the exchange. Secondly, as mentioned, the simulations are based on a comparison with purely commercial transactions in the spot market, whereas it is known that for many of the selected countries, concessional transactions make up a considerable share of cereal imports. Thirdly, it may be that a dynamic hedging strategy along with the seasonal import pattern, and possibilities for substitution among food products, may make a difference to outcomes.

Finally, as noted in Sarris et al. (2011) these rules will reduce neither the risks involved in variable transactions costs, or transport costs, nor the risks involved in foreign exchange. Some of these risks may be substantial in developing countries, and as they cannot be diversified through the rules simulated here, they may diminish the effectiveness of hedging. Foreign exchange risk can be dealt with in foreign exchange futures and options markets, and it may be possible to hedge also some of the transport costs in organized markets. Also, it might be possible to hedge part of the basis risk, which may be large for some countries, through organized regional exchanges. This may be possible in some of the countries included in our sample, such as India, China (Mainland) and South Africa. However, it is not clear that such exchanges offer good hedging media for imports to be purchased internationally. These issues call for more extensive research that might involve additional products and markets.

The implications for development policy are that many LIFDCs may benefit from encouraging their main import agents to institute more predictable food import expenditure schemes based on the hedging rules of the type suggested in this chapter. There are important benefits from increased predictability especially in securing food supplies, and hence the assurance for many developing countries that they will not have to reallocate development funds to deal with short-term food crises. This, in turn, could lead for a more orderly pattern of public investments and hence potentially faster growth.

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Chapter 20

Using risk management tools to manage price volatility in food imports: practice

Morgan Stanley Commodities Group

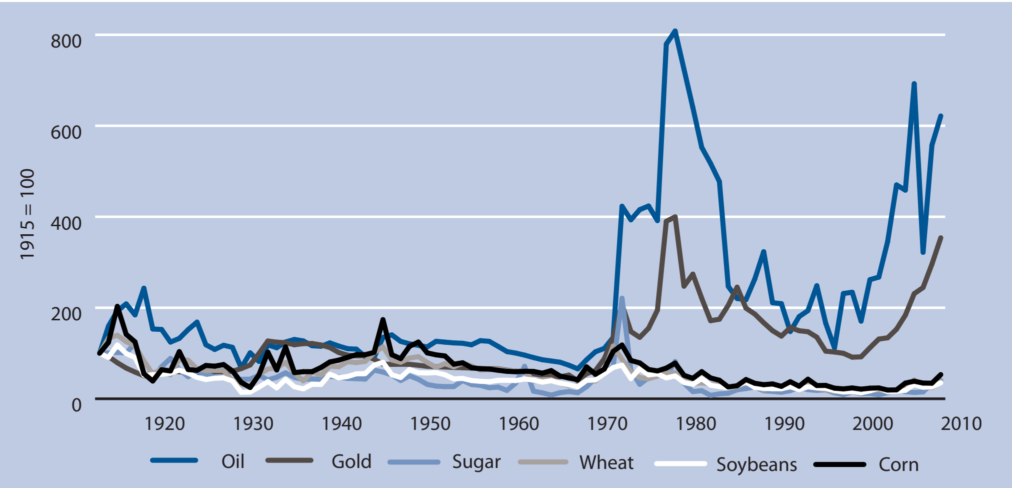
The last half-century has seen a significant rise in the demand for agricultural commodities owing to factors such as global economic development, urbanization and demographic growth. This has served to tighten the market, and as a result, supply issues are becoming more of a determinant of volatility and pricing – thus magnifying the effects of supply shocks. Supply factors that typically come into play include the weather, conflicts, government intervention, land-use competition and infrastructure issues. Indications are that several factors described above and numerous others that characterize the current market environment are likely to persist, and indeed be exacerbated, in the coming decades.

Over the last few years, we have become increasingly aware of the volatility and general upward trends broadly inherent in commodity prices. However, agriculture prices in real terms have remained significantly lower than they were a century ago and, in fact, are basically close to their lows of the century (Figure 20.1). The downward trend in agricultural prices since the mid-1970s, against the backdrop of population growth, would point to marked supply productivity gains through that period, which now appear to be moderating. The price trend in agriculture contrasts sharply with those of gold and oil, which are priced significantly higher in real terms now. Agricultural prices certainly have the scope for sustained increases relative to other commodities.

For consumers or importers of agricultural products, the possibility or prospect of a volatile and rising price environment for commodities deemed essential for food security, presents some serious challenges. Thus, the factors and trends mentioned above make this an appropriate and timely juncture to explore risk management in agricultural markets thoroughly.

This chapter seeks to demystify certain concepts surrounding risk management for governments. The authors delve into the rationale, approaches, experiences and methods of agricultural price risk management for governments. Simulations, case studies and logistical considerations are incorporated for a more practical explanation. The authors' experience of risk management with large clients, agricultural hedgers and governments in particular is drawn on throughout the chapter.

Figure 20.1: Commodity real price evolution: index points (1915=100)



Source: Morgan Stanley Commodities, Bloomberg, Morgan Stanley Research.

Objectives of a risk management programme

It is critical to note that a number of factors affect the price of agricultural products including: supply and demand fundamentals in a given agricultural product, weather in producing regions, demographic growth and economic development in consuming regions, natural disasters, global crises and conflicts and the development of biofuels. Most of these factors are highly unpredictable, and the rapid changes that can occur in the supply and demand balance may translate into short-term spikes or longer-term structural shifts in the market.

In this context, consumers and users of these commodities should consider the opportunity of using forward markets[1] to implement a risk management strategy. Risk management using *derivatives* provides the consumer with the opportunity to lock in or protect against a price rise in a specific market, better plan the cost associated with the purchase of agricultural commodities and enhance budget predictability. This is achieved by externalizing the risk to the market. Similarly, commodity producers have been using commodity *derivatives* to lock in or protect their revenues.

Risk management application

Company risk management

Various industries have been using commodity *derivatives* for many years in order to manage their price risk, especially with regard to energy. The airline industry is probably the most mature industrial user of commodity exchanges for risk management purposes. Airlines utilize the oil and jet fuel forward and options markets to manage their fuel price risk.

1 Forward markets are markets in which financial instruments (forward contracts) are bought and sold for future delivery at prices mutually agreed upon today. Forward contracts are not standardized and can be of varied characteristics such as volumes, periods and settlements.

As risk management programmes have evolved in the airline industry, some best practices have emerged that can be applied more widely. The more sophisticated airlines' risk management programmes are now consistent and disciplined in both upward and downward trending markets. Conversely, the less sophisticated risk managers may have a tendency not to act when prices rise and act quickly when prices fall. This can result in an under-hedged position at times when risk is greatest.

Therefore, one of the central tenets of a risk management programme is to institute a disciplined approach towards execution and protection-building, with rules and guidelines for every step of the process.

Last, but not least, it is of the utmost importance that a risk management programme is understood thoroughly before proceeding with its execution. In particular, once the choice of instruments is made, it is crucial that "worst-case" scenario simulations are undertaken to understand how the structures could impact the hedger in terms of cash flow, credit exposure, collateral and margin calls.[2] The impact would need to be detailed and explained to the decision-makers and stakeholders in order to ensure that all potential outcomes of the hedging are understood and acceptable. Partner banks should be able to help with the necessary analysis and reporting.

Government risk management

Governments can be exposed to agricultural commodity price risk in two different ways. On the one hand, they could have a producer's exposure because some of their revenues are linked to prices of these products, either directly in the case of large producing countries, or indirectly via taxation of exports of these products. On the other hand, they could face a consumer's exposure, because they must secure large imports of agricultural products for domestic consumption or ensure an acceptable domestic price for these products in order to mitigate the social, economic and political impact of higher commodity prices on the population.

It is this latter scenario – when governments import or consume agricultural products – that is the basic focus of this chapter.

In the past, only a few governments globally have used commodity derivatives to protect against price risk. There are a number of reasons why some governments with large exposures in these markets have not tended to actively manage their risk in an appropriate way, or at all. These include:

1. Incorrect understanding of derivative instruments and markets. In particular, words like "derivatives" and "options" have been associated with risky and speculative behaviour owing to relatively isolated misuse that has caught the media's attention. However, companies across many industries commonly use these instruments on a regular basis in an appropriate way to facilitate effective risk management.
2. Concern with "getting it wrong". Hedging has often been associated with simply "fixing prices" that could result in situations where the government incurs negative cash flows and foregoes benefits if prices subsequently fall, thus exerting pressure on the government and hedging committee. However, there are other instruments with relatively limited and finite cash flow liability, such as call options and call spreads, that could help counter the issue of risk. These alternative instruments will be explained further in this chapter.

[2] A margin call refers to the collateral required to cover negative credit exposure arising from adverse movements in derivative contracts. It is usually calculated and adjusted daily.

3. Bureaucracy. Response time is of key importance when dealing with commodities markets. This can be problematic for governments owing to the typical bureaucracy involved with putting the framework in place, obtaining the authorizations and explaining the concept and strategy to the different parties involved. The government could see the favourable market pricing opportunity disappear by the time the set-up is completed.
4. Political and reputational risk. Where the responsibility for the decision rests with one person or a group, concerns about public perception could mean they abstain from risk management. This may be preferable to undertaking risk management decisions that could result in negative cash flows that can then be attributed to them. This potential problem can be addressed by putting the appropriate authorities and structure in place – another area we focus on in more detail later in this chapter.
5. Credit Constraints. There is an element of credit risk inherent in the use of derivatives in risk management, based on the ability of a counterparty to perform its contract obligations. Therefore, governments with a poor credit rating may encounter difficulties when trying to enter into instruments that are credit-intensive such as swaps or collars, or for longer tenors.[3] Call options are much less credit-intensive and may be a solution for these governments. Poorer countries may also be able to work with supra-national organizations, such as the World Bank, to access the markets on their behalf.

While all of these barriers to hedging are certainly valid, they can be appropriately managed and contained with the right approach to risk management, which involves a good understanding of the markets and instruments as well as the formulation and implementation of a detailed risk management policy.

Instruments utilized in risk management

The term "derivatives" refers to financial instruments, the prices and settlements of which depend on the evolution of value of an underlying asset or commodity. There is a broad spectrum of derivatives, ranging from very simple "plain vanilla" products to the more exotic types. In commodity risk management, and particularly for government use, we discuss here the more standard and simple instruments that are widely available in the market.

Exchange-listed commodities have a futures market in which participants can buy and sell the commodity at a future date directly on the exchange via these instruments. They are standardized in their specification, size, maturity, expiry date and settlement procedure and involve daily margining by the exchange.

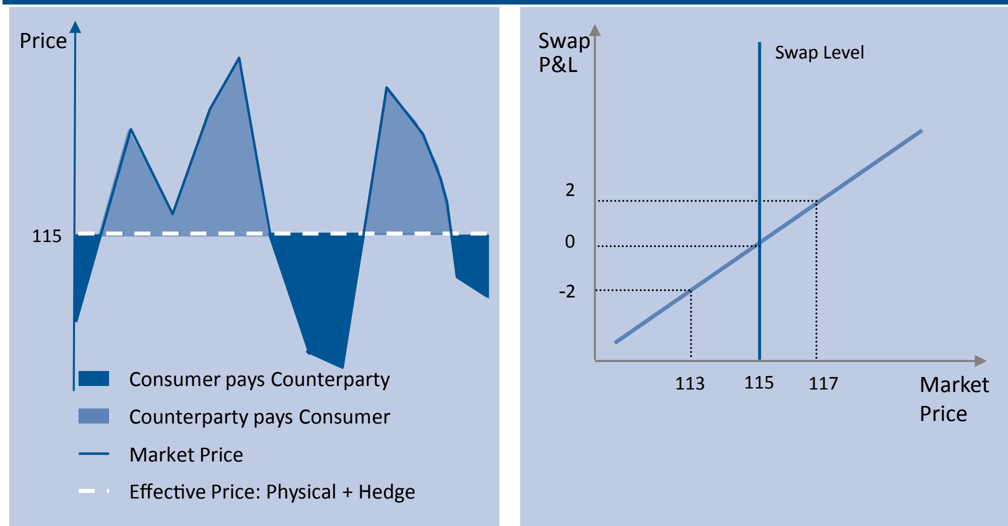
Besides the futures exchanges, over-the-counter (OTC) markets have developed and account for most of the liquidity for instruments related to markets later in time (for instance, hedging a wheat exposure three years ahead). These are markets where participants directly and mutually agree on transactions. Prices are easily obtained and are comparable to the futures markets with the added flexibility of tailor-made products in terms of size, maturity, expiry date and settlement procedure. However, there is a credit risk element associated with OTC products as transactions are executed directly between parties and are not necessarily collateralized. This can be preferable to many corporations and governments who may prefer to utilize open credit lines with the banks rather than dealing with daily margin or collateral payments associated with a futures exchange.

Swaps

The simplest OTC instrument is a swap. This is a forward transaction, which represents an obligation to buy or sell the commodity over a specified time period. The obligation to buy

3 A "tenor" refers to the maturity of the instrument.

Figure 20.2: Illustration of a swap strategy



Source: Morgan Stanley Commodities.

or sell is a fundamental element of these contracts and represents the key difference to option transactions (Figure 20.2).

Average price swaps are OTC instruments that provide the users with a method of fixing their commodity price at an average level for the duration of the contract. These instruments have proven popular with buyers and sellers who have continuous exposure to commodity prices and who wish to simplify the way they manage their pricing risk. Swaps involve no physical delivery and are cash settled, typically against the average of the price of the underlying commodity over a specific period. This underlying, in most cases, is the more liquid exchange front-month futures contract. They are liquid tools that ease the operational and transactional burden on both producers and consumers of commodities.

Swap price exposure is symmetrical. For a consumer who buys a swap, if the average price rises, the potential cash flow on the swap will be positive. Conversely, if the average price falls, the potential cash flow will be negative. If the swap is being used to hedge physical costs (the purchase price), an increase in outward (negative) cash flows against the physical purchases will be offset by the gain in inward cash flows from the swap contract so, on a net basis, the price for the consumer is fixed at the swap price. This fixed price effect is also the same if prices fall, i.e. improved cash flows on the physical contracts are offset by negative cash flows from the swap contract.

In the above example, the government buys a swap at USD 115[4]. The government is therefore fixing its purchase price at $115.

If the average price over the period is below $115, the government will have to pay the difference between the fixed price ($115) and the market price – for example, paying $2 at a price of $113. In the meantime, it would be buying its physical commodity at the prevailing market rate which is $113, therefore having a net cost of $115 ($113 physical + $2 paid on the hedge).

4 From hereon, all currency ($) quotations refer to United States Dollars.

Conversely, if the average price over the period is higher than $115, the government will receive the difference (example: it will receive $2 at a price of $117). At the same time, the government will be buying its physical at $117. The net price for the government, combining the physical purchase and the hedge, is therefore $115. In this example, by buying the $115 swap, the government has fixed its price exposure to $115.

A swap is the simplest instrument; it is costless to implement and generally easy to understand by the public. However, in the case of a government, the risk could be perceived as high in a falling price environment, where the necessary payouts on the hedge could be seen as a lost opportunity for the government to use that money for other development purposes. If this is a concern for governments, then using options should be considered.

Options

A holder of an option has the right to choose whether to effect a particular transaction by a certain date. This is known as "exercising" the option.

There are two main types of options: *call options* and *put options*. A call option is the right to buy the commodity (whether futures, physical or cash settled) at a specified price by a certain date. Conversely, a put option is the right to sell (whether futures, physical or cash settled) at a specified price by a certain date.

The product specified in an option contract is the underlying commodity. The price at which the option's underlying commodity would be bought or sold, if the option holder chose to exercise the option, is the strike price. The strike price relates to the purchase price referenced in a call option, or the sale price specified in a put option. An option contract will also include the established time by which the owner must elect to either use (exercise) the option or not: the expiration date or maturity date. Most options are referred to as "American" or "European" style. American options can be exercised at any time prior to expiration, but European options can only be exercised on the maturity date. As an example, a company that holds an American call option for May Chicago Board of Trade (CBOT)[5] wheat with a strike price of $5.95 that expires on 8 April has the right, but not the obligation, to buy May CBOT wheat at $5.95 on or before 8 April. A holder of a put option, with otherwise the same specifications, has the right, but not the obligation, to sell May CBOT wheat at $5.95 on or before 8 April.

Asian options are another option category, but the term has nothing to do with any exercise restrictions. Instead, the profit/loss of an Asian option is determined by comparing the option's strike price with an average of the underlying commodity prices over a period (e.g. a monthly average of cotton prices). Asian options are also called average price options, or APOs. This type of option is usually used in the OTC market because the cash settlements are made automatically each settlement period (usually monthly) when the option is "in-the-money".

After the expiration date, the rights of the option holder no longer exist, and an unused option is said to have expired or lapsed. An option holder may also re-sell the option prior to its expiration in the market, just as one can re-sell a futures or forward position before the termination of trading. Thus, the owner of an option has three alternatives with which to dispose of his option: exercise the option, allow the option to expire unused or sell out of the option position before expiry.

5 The Chicago Board of Trade is a designated market operating a futures, derivatives and options exchange for a variety of products including commodities.

Box 20.1: Average price derivatives – a closer look

An average pricing derivative (or Asian derivative) is a contract with a payout determined by an average of underlying prices over a pre-agreed period. This is different from European derivatives such as those traditionally listed on the exchange (futures, listed options) where the payoff is determined by the underlying price on a single date, at maturity.

Average pricing derivatives (both swaps and options) are the most commonly traded in OTC commodities markets, with averages usually assessed on a monthly basis.

The main reason behind the use of these types of options is that the commodity price exposure for both consumers and producers of commodities is often spread over the month rather than at one point in time. A producer of soybean oil will sell regularly throughout the month rather than on one day at the end of the month. Similarly, a country that imports wheat would be buying wheat regularly to match its domestic consumption rather than on one single day.

Another benefit of average pricing products is that they avoid the risk to the hedger of being impacted by the price movement on a single day. Instead, hedgers are exposed to an average price or trend over a period. This reduces the volatility of the underlying reference and therefore contributes to Asian options being cheaper than European options.

Below is a typical example of how a confirmation for a French MATIF (Marché à Terme International de France) milling wheat monthly pricing instrument would be worded:

Floating Price: With respect to a Calculation Period, the unweighted arithmetic mean of the Relevant Price for each Pricing Date during the Calculation Period.

Relevant Price: A price for a Pricing Date will be that day's settlement price per tonne of deliverable grade milling wheat on EURONEXT LIFFE of the First Nearby Month Futures Contract, stated in Euros and Euro cents, as determined by EURONEXT LIFFE on that Pricing Date.

Calculation Period: Each calendar month from and including the Effective Date, to and including the Termination Date.

The settlement can be either cash settled, by comparing the reference price with the strike price and settling the difference, or "physically" settled with the option holder buying a future or swap at the agreed price (strike) from the option seller.

An option holder can only purchase an option if some other participant is willing to sell that option. Liquidity (availability) of options at competitive prices is usually not a problem when using the most-traded commodity indices. The seller of an option is also referred to as the grantor or writer of an option. The buyer of a call option has obtained the right to buy the underlying commodity (e.g. wheat) from the seller of that option. If the buyer chooses to exercise the call option, then the company that sold the option is obligated to sell wheat to the buyer at the option strike price. If the buyer of a wheat put option exercises the right to sell, then the company that sold that put option is required to buy wheat from the option holder. For both puts and calls, the buyers of options gain rights while the sellers of options incur potential obligations.

As there is no obligation to exercise an option, it will only be used when it is a profitable alternative.

The market advantage – the ability to use the option when it is beneficial or to allow it to lapse when the current price is more favourable – comes at a defined cost: the option premium.

Table 20.1: Factors affecting the premium of an option

	Put option	Call option
↑ Time To Expiry	↑	↑
↑ Volatility	↑	↑
↑ Strike Price	↑	↓
↑ Underlying Price	↓	↑

Commodity options are priced in the same denomination as the underlying commodity. A premium of $0.15 per bushel to buy a corn option for 10 000 bushels of corn represents a total cost of $1 500 for that option. The buyer of the option typically pays the premium to the seller when the option is purchased. However, it may be possible to agree with the option seller to defer the payment of the option premium. It should also be possible to price the option in local currency, if preferred.

The determinants of the option price are the variables that determine the probability of the option expiring "in-the-money" or not.

The five major factors that affect options prices are (1) the time to expiry; (2) price volatility of the underlying commodity; (3) the strike price; (4) the market price of the underlying; and (5) interest rates (Table 20.1).

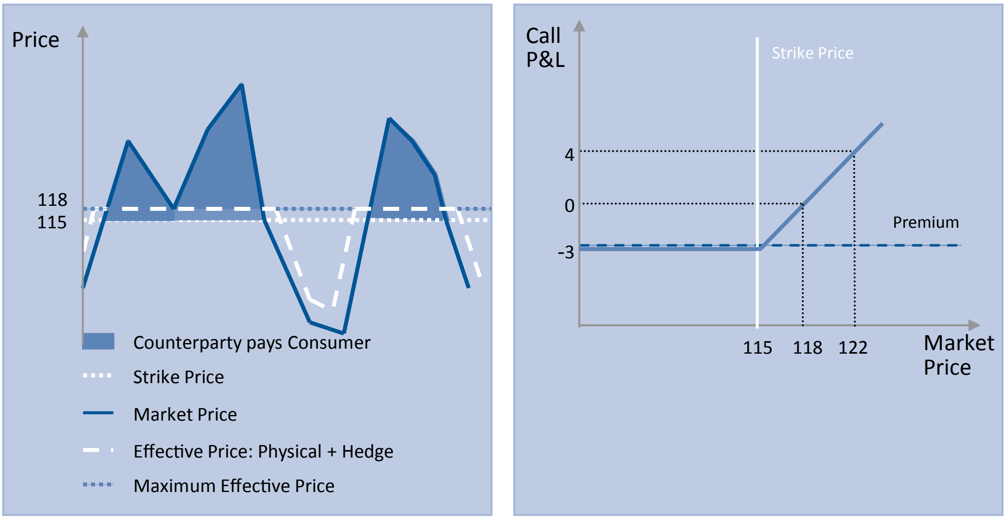
1. The longer the time to expiry, the more expensive the option will be, as there is more time for market conditions to change, which could move the market price significantly through the option strike price.
2. A higher market volatility implies a higher likelihood that the market reaches the strike price, therefore increasing the cost.
3. A higher strike price for a put makes the option more expensive, because the holder of the option has the right to sell the underlying commodity at a higher price (if exercising the option). Conversely, the call less expensive because the option holder has the right to buy the underlying commodity at a higher price (if exercising the option). The closer the strike is to the prevailing market price, the more expensive the cost will be.
4. A higher underlying market price, with other factors constant, would increase the cost of a call option and decrease the cost of a put option.
5. Changes in interest rates are generally the least important factor in determining option pricing, as they will affect the discounting factor applied in the premium calculation.

In the example shown in Figure 20.3, the government pays $3/unit to buy the $115 call option. The total cost is this premium of $3 multiplied by the total volume hedged under this contract. This premium cost is usually paid up front, similar to an insurance premium. The government is therefore protected against a price rise above $115 and will still benefit in a falling price environment.

If the average price over the period is below $115, the option will not be exercised and there is no further exchange of payment. The government's cost associated with the strategy is limited to the premium paid of $3 on its financial hedge. On the physical market, the government will be able to buy its commodity at the prevailing market price (lower than $115).

If the average price over the period is higher than $115, the government will receive the difference (example: it will receive $7 at a price of $122). The net benefit of the hedge

Figure 20.3: Illustration of a call strategy: buying a call (long call)



Source: Morgan Stanley Commodities.

will be the positive cash flow minus the premium ($7 – $3 = $4 in this case). In parallel, the government will be buying its physical at $122. The net price for the government, combining the physical purchase and the hedge, is therefore $118 (which is the strike + premium).

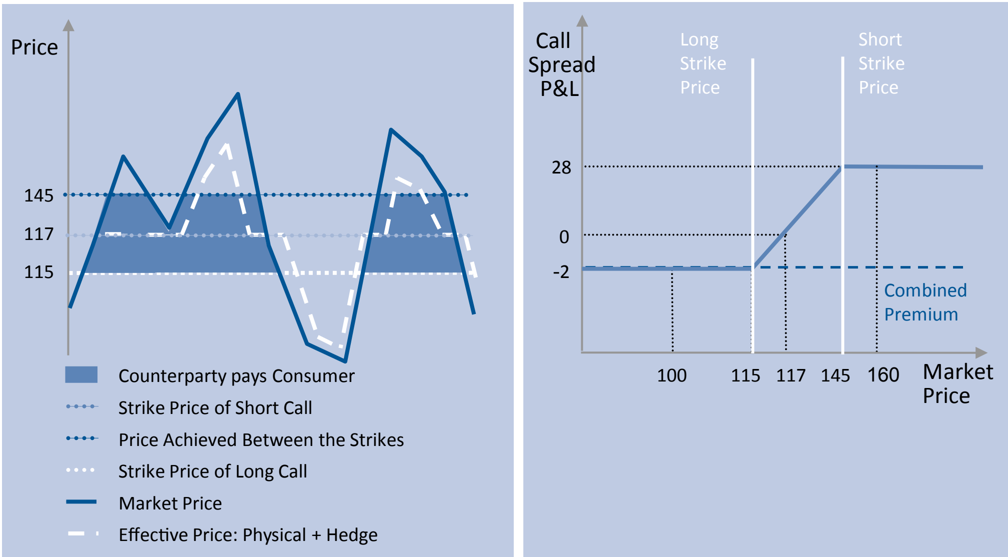
In this example, by buying the $115 call option at $3, the government has ensured that its price exposure is capped at $118.

> ***A Practical Example:***
> *The owner of a call option on July cotton with a strike price of $1.30/lb will exercise the right to buy only if July cotton prices are at least $1.30/lb. If prices were lower (e.g. $1.20/lb), the owner of the $1.30/lb option would be better served by letting the option expire unused and buy July cotton directly in the market at a lower price. Even if the price of July cotton were only slightly lower than the strike price (e.g. $1.28/lb), the option holder would be better off purchasing directly from the market.*

Average price call options are OTC instruments that provide the user with a method of protecting or insuring against higher average commodity prices over a period. These instruments have proven popular with buyers with continuous exposure to commodity prices and who wish to protect against rising prices while retaining the potential benefit of lower prices in a downward market. Similar to swaps, these APO call options involve no physical delivery, and are cash settled against the average price of the underlying over a specific period.

Unlike swaps, call options do not lock the consumer into a fixed purchase price, so the consumer will be protected in a rising market but will benefit from falling prices. The negative cash flow is known at the inception of the trade and is limited to the premium (option cost). In this way, these options are often thought of as similar to classic insurance policies; they have an upfront cost (premium) but potential positive cash flow (the option payout) when the risks exceed a pre-determined level.

Figure 20.4: Illustration of a call spread strategy



Source: Morgan Stanley Commodities.

Alternative strategies

In some instances, the government may look at alternative strategies for its hedging. For example, in a high volatility environment, the cost of a call option could rise substantially and prevent the government from executing its hedging programme. Other instruments may be more appropriate in these instances. They are discussed below.

The call spread strategy is a combination of buying a call (long call) and selling a call (short call) at a higher strike on the same underlying commodity and for the same period, aiming to reduce the cost of the hedge or insurance by giving away some of the protection, resulting in limited protection.

In effect, the customer buys a call to protect against higher prices. Simultaneously, the customer sells a call at a higher strike and collects the premium of that sale, thus reducing the overall cost of the strategy. The sale of the higher call will reduce the total cost of the strategy but will also limit the protection: the maximum cash flow this strategy will generate is the difference between the strike prices of the long and short call options (minus the net premium). The buyer is exposed to the rise in prices above the higher strike. Figure 20.4 illustrates the payoff of the call spread strategy, taking the example of a 115/145 call spread:

In the example shown in Figure 20.4, the government pays $2 to buy the 115/145 call spread. The strategy is a combination of a long call at $115, which costs $3, and the sale of the $145 call, which pays $1, creating a call spread with a net cost of $2.

The government is therefore protected against a price rise above $115 up until prices are above $145, while still benefiting from market prices in a downward price environment.

If the average price over the period is below $115, no option is exercised and there is no exchange of payment. The government's cost associated with the strategy is limited to the premium paid of $2 on its financial hedge. On the physical market, the government will be able to buy its commodity at the prevailing market price (lower than $115).

If the average price over the period is higher than $115 and below $145, the government will receive the difference between the reference market price and the strike of the long call (for example, it will receive $7 at a price of $122). The net benefit of the hedge will be the positive cash flow minus the premium ($7 - $2 = $5 in this case). In parallel, the government will be buying its physical at $122. The net price for the government, combining the physical purchase and the hedge is therefore $117.

If the average price over the period is higher than $145, the government will only receive the difference between the two strikes ($145 - $115 =$30) and will therefore be exposed to further price movements. For example, if the market averages at $160, the government will receive $30 on its hedge (so, a net cash flow of $28 including the premium) but will have to pay the prevailing market price of $160 on its physical purchase. Its net position, when including the physical and hedge, will therefore be the physical cost of $160 minus the hedge benefit of $28, resulting in a net cost of $132.

This strategy guarantees the government a net price of $117 if the market price does not move above the higher strike of $145. Above that, the government will be exposed to further increases ($15 more than $117 at a market price of $160 in our example).

This strategy can be cost effective compared with to the normal call option in a high volatility environment, as it is not as greatly impacted by higher volatility (the sale of a call partly offsets the volatility effect of the call bought). It also works very well in an environment where it is perceived that prices have a limited upside potential. This strategy could well represent 20-40 percent of a total hedging portfolio. It retains the benefit of a call option in that the liability (cost) is limited and finite and so is also less credit intensive.

The collar strategy is a combination of a long call and a short put. The government buys a call that is financed partly or totally by the sale of a put at a lower strike. The government is protected against rising prices above the call strike level by receiving the difference between the market price and the call strike. However, the government will forgo the benefit of lower prices below the put strike by paying the difference between the put strike and the market price to the collar provider, as shown in the following example:

In the example shown in Figure 20.5, the government buys the $125 call and sells the $90 put for zero net premium (commonly referred to as a zero-cost collar, or ZCC). The strategy is a combination of a long call at $125, which costs $2.50, and the sale of the $90 put, which pays $2.50, resulting in a zero-cost strategy.

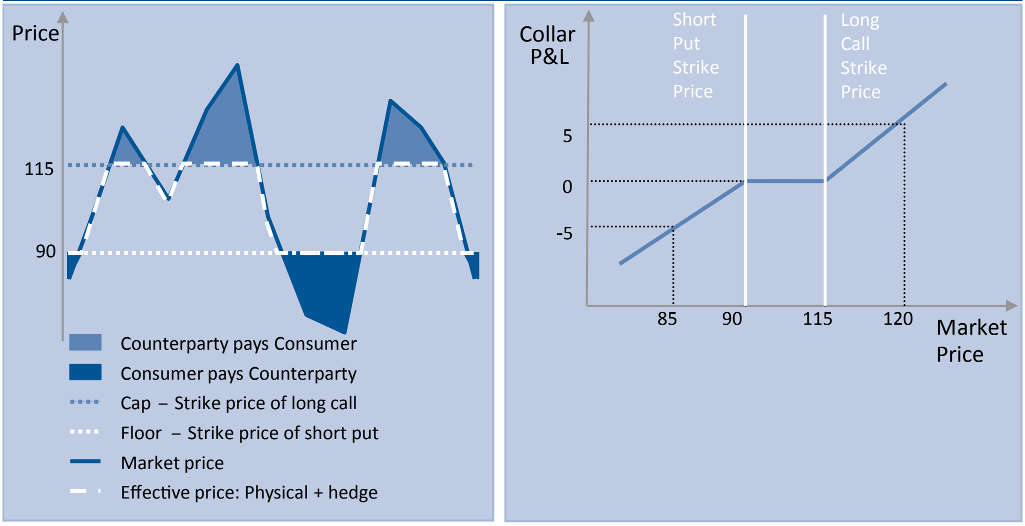
The government is therefore protected against a price rise above $125 by receiving the difference between higher prices and the strike of $125 (it will receive $5 at the price of $130). The net price, when combining the physical purchase at the market price of $130 and the hedge for the government, is therefore set at $125 ($130 physical less the $5 received on the hedge).

There will be no exchange of payments when the market price is between the put strike and the call strike ($90 and $125 in this example), and the government's net exposure will be the actual price it pays for its physical purchases.

If the average price over the period is below $90, the government will need to pay the difference between the put strike and the market price (paying $5 at the price of $85, for example). The government would then effectively set a floor for its net price and any physical purchase cheaper than the put strike (cheaper than $90 in the example) will be offset by the payment that would be made on the hedge contract, therefore setting a price floor at the put strike level ($90 in the example).

This hedging instrument can guarantee the government a ceiling on its purchase price at a zero premium, but there is the potential liability associated with the short put position, i.e. a floor is set on the purchase price.

Figure 20.5: Illustration of a collar strategy



Source: Morgan Stanley Commodities.

Therefore as with swaps, this strategy has a "political" risk: in lower price environments there may be complaints of a missed opportunity owing to the structure of the instrument. This strategy should therefore be used carefully by governments and only applied to a smaller portion of the total hedging portfolio. It should only be used when the put strike can be set at a level that is relatively low and would be broadly accepted, thereby limiting downside risk.

Planning and implementing a risk management programme

Initial considerations

To set up a robust risk management programme, governments should take certain key steps:

1. Designate appropriate hedging instrument(s) that may be used for the purposes of hedging its physical commodity exposure. Governments need to understand and be ready to accept worst-case outcomes that may arise with the use of the chosen instruments.
2. Determine the maximum amount or quantity of agricultural products that should be hedged. This would require input from the departments responsible for the physical procurement. There is a risk of being over hedged if physical purchases eventually turn out to be less than the volumes hedged. It is also important to consider the country's total risk exposure in all agricultural commodities in order to make the final decision on the level of the exposure to be covered by hedging, i.e. considering all direct and indirect exposures.
3. Establish, in advance, the time frame and execution frequency for the hedging strategy. For instance, a strategy may be a quarterly programme for the next two years (initial implementation of hedging two years forward within three months of this policy being in place, and then additional hedges executed on an ongoing basis to meet policy every quarter). A rolling-strategy could state that the government would hedge 60% to 75% of its consumption or production for the first six months, between 60% and 45% for months seven to twelve, between 30% and 45% for months 13 to 18 and 15% to 30% for months 19 to 24 as summarized in Figure 20.9. Every three months, the government should therefore top up its hedging for all months that need an increase in their coverage ratio as

Box 20.2: A study and comparison of different hedging strategies over time

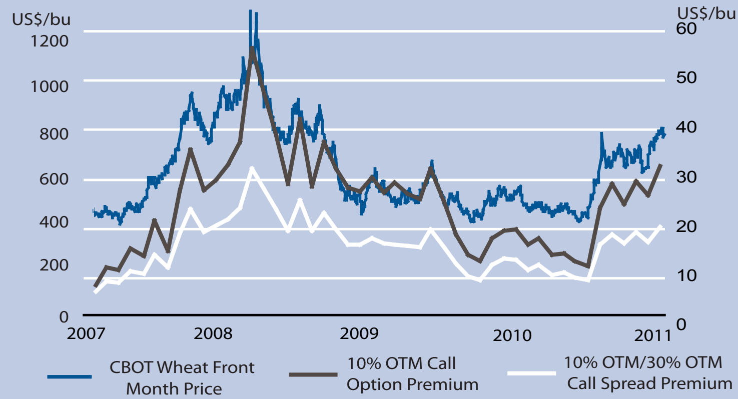
Here, we outline a study that was carried out with the purpose of evaluating the performance of the various hedging strategies we have described so far.
We have focused on the wheat market from 2007 onwards. Since January 2007, the agricultural commodity markets have been characterized by periods of high levels of volatility in both rising and falling price environments. This allows us to consider how the strategies compare in different market environments.
We have calculated the cost of each strategy as of the last business day in each month since January 2007. In each case, we use a strategy providing price protection for the six months following the execution date:

- A structure priced as of 30 January 2009 would price out (provide protection from rising prices) over the six months from February to July 2009.

Figure 20.6 below shows the evolution of the premium (cost) of two of our considered strategies since January 2007:

- 10% OTM (out of the money) wheat call option.
- Wheat call spread (buy 10% OTM call; sell 30% OTM call).

Figure 20.6 CBOT wheat premium and hedging strategy premium

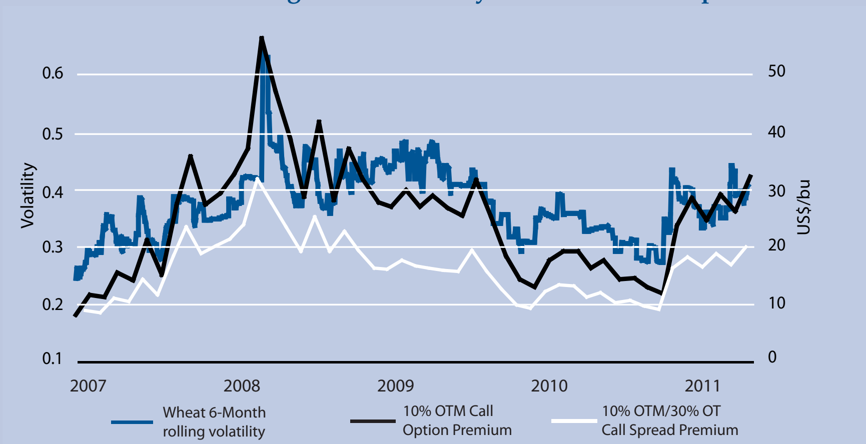


Note: The specific structure considered is an APO Call Strip, with even volumes across each of the six months; 10% OTM (Out-of-The-Money) means the call strike price is 10% higher than the market price of the underlying, for the same pricing period, at the time of the transaction. Source: Morgan Stanley Commodities.
It is immediately clear that the 10% OTM call option strategy is always more expensive than the 10% OTM/30% OTM call spread strategy. As previously explained, this is because the call spread involves "selling away" some of the unlimited protection against rising prices that a call option provides.

The cost or premium of the two strategies, and the difference between these two premia has varied significantly over time, however. This is explained by the level of volatility in wheat prices over time.
We know that increased volatility in the underlying price makes options more expensive, as it increases the likelihood of larger price moves in either direction. Therefore, in periods of high volatility in the wheat market, the premium or cost of the 10% OTM call option increases, while the premium of the 30% OTM call option also increases (see Figure 20.7 below).

- During the agricultural commodity price spike that peaked in early 2008, we see the price of call options and call spreads peaking, while the spread between the two prices also reaches its widest level.
- Wheat swap ("at the money", ATM, no premium required).
- 10% OTM wheat call option.

Figure 20.7 Six-month rolling wheat volatility and CBOT wheat premium



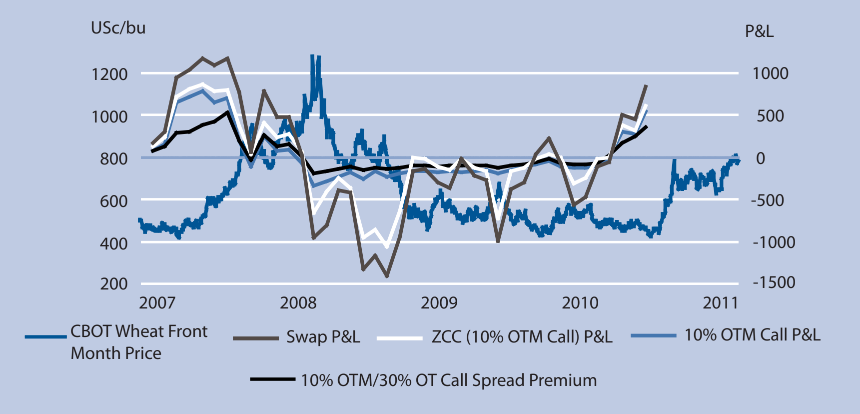
Source: Morgan Stanley Commodities.

Figure 20.8 shows how some of our considered strategies have performed since January 2007 (assuming that the structures are held to expiry).

- Wheat call spread (buy 10% OTM call option, sell 30% OTM call option).
- Wheat zero-cost collar (buy 10% OTM call option, sell put option for the same premium).

Each data point on a Profit and Loss (P&L) line in the figure shows the realized profit or loss of the instrument priced as of that date, which is active for the following six months. This P&L is inclusive of the premium.
For example, the 30 January 2009 value for the call option represents the P&L generated by a six-month 10% OTM call option purchased on that date, having priced out during February – July 2009.

Figure 20.8 CBOT wheat price evolution and hedging strategy realized P&L



Source: Morgan Stanley Commodities.

Key take-away messages from the analysis in terms of a comparison between the different strategies are that:

- The **swap** provides the best performance during a rising market, but the worst during a falling market, with potential gains unlimited and losses limited only to the swap level (in the unlikely case that the price falls to zero).
- The **zero-cost collar (ZCC)** provides a similar performance to the swap, but it makes smaller gains in a rising market and smaller losses in a falling market.
- The performance of the **call option** in rising markets will always be slightly lower than that of the ZCC. This is because while the call has the same strike-price for upside protection as the ZCC, the P&L will be lower owing to the premium paid for the call. In a falling market, however, the call option's loss is limited to this premium, while the ZCC's losses can increase to the equivalent of the short put strike in the unlikely case that the price falls to zero.
- The P&L of the **call spread** resembles that of a call option to a certain degree. In a falling market, when the loss of both structures is equal to their respective premia, the performance of the call spread benefits from the fact that its premium is lower. In a rising market, so long as the gains do not exceed 30% (the percentage by which the short call leg of this strategy is OTM) of the initial swap level, the call spread will also outperform, again benefiting from its lower premium. However, should the gains in the underlying exceed 30%, the call spread's P&L will be capped, while the call option will continue to benefit from all further price increases. If this is the case, the performance of the call option will exceed that of the call spread – an example being structures bought in the first half of 2007.

Table 20.2 below summarizes the total profit or loss that would have been generated by December 2010 by entering into a rolling six-month hedging programme from January 2007 onwards. These P&Ls are net of premium.

- The first column lists the four instruments that have been used in this simulation, each of which has been described in some detail earlier in this chapter.
- The second column shows the total profit on the hedging programme from January 2007 based on a total volume of one bushel of wheat in each month for the entire rolling hedging programme.
- The third column presents the total profit or loss, over the entire period from January 2007 to December 2010, on a hedging programme which protects against rising prices for a total 100 000 tonnes of wheat in each month.

Table 20.2 Overall profit and loss generated by a rolling six-month hedge: Jan 2007 to Dec 2010

Total Instrument	Total P&L with a monthly underlying of one bushel (USc)	Total P&L with a monthly underlying of 100 000 tonnes (USD)
Swap	-28.32	-1 039 344
10% OTM call	323.24	11 862 908
10% OTM/30% call spread	266.62	9 784 954
Zero-cost collar (10% OTM call)	82.58	3 030 686

Note: 36.7 bushels are equivalent to one tonne of wheat.

For instance, since 2007, a strategy of purchasing 10% OTM call options on CBOT wheat at the end of each month for the following six months would have yielded a total profit of USc 323.24 on the basis of one bushel of wheat per month hedged in the rolling programme. Assuming that the total monthly volume hedged each month since January 2007 was 100 000 tonnes of wheat, then this is equivalent to a total profit of $11 862 908.

Given the volatility in the wheat market since January 2007, the performance of the different instruments has varied somewhat over time. Tables 20.3 to 20.6 summarize the profit or loss made by the hedging programme in the different years it would have been in place.

- Note that the tables reflect the profit or loss of the instruments purchased in that year, so the 2007 table reports the profit and loss (P&L) of instruments entered into in 2007, although some of these would have priced out in 2008.
- Note that the first half of 2010 is reported rather than 2010 as a whole. This is because instruments purchased in the second half of 2010 would partly price out in 2011 following the completion of this study.

Table 20.3 Profit and loss from a rolling six-month hedge: 2007

Instrument	P&L with a monthly underlying of one bushel (USc)	P&L with a monthly underlying of 100 000 tonnes (USD)
Swap	1 407.86	51 668 462
10% OTM call	705.28	25 883 776
10% OTM/30% call spread	476.07	17 471 769
Zero-cost collar (10% OTM call)	938.01	34 424 967

Table 20.4 Profit and loss from a rolling six-month hedge: 2008

Instrument	P&L with a monthly underlying of one bushel (USc)	P&L with a monthly underlying of 100 000 tonnes (USD)
Swap	-1 323 04	-48 555 568
10% OTM call	-407.26	-14 946 422
10% OTM/30% call spread	-239.74	-8 798 458
Zero-cost collar (10% OTM call)	-867.46	-31 835 782

Table 20.5 Profit and loss from a rolling six-month hedge: 2009

Instrument	P&L with a monthly underlying of one bushel (USc)	P&L with a monthly underlying of 100 000 tonnes (USD)
Swap	-562.70	-20 651 090
10% OTM call	-264.16	-9 694 672
10% OTM/30% call spread	-168.51	-6 184 317
Zero-cost collar (10% OTM call)	-334.79	-12 286 793

Table 20.6 Profit and loss from a rolling six-month hedge: first six months of 2010

Instrument	P&L with a monthly underlying of one bushel (USc)	P&L with a monthly underlying of 100 000 tonnes (USD)
Swap	449.56	16 498 852
10% OTM call	289.38	10 620 246
10% OTM/30% call spread	198.80	7 295 960
Zero-cost collar (10% OTM call)	346.82	12 728 294

In Table 20.7, we show a summary of the performance characteristics for each of the strategies.

Table 20.7 Performance characteristics of hedging strategies

	Protection against price increases	Benefit from price decreases	Upfront cost
Swap	√	x	Zero
Call	√	√	Premium paid out
Call spread	√ (Limited)	√	Premium paid out
Collar	√	x (limited)	Zero/premium paid out
√ = yes x = no			

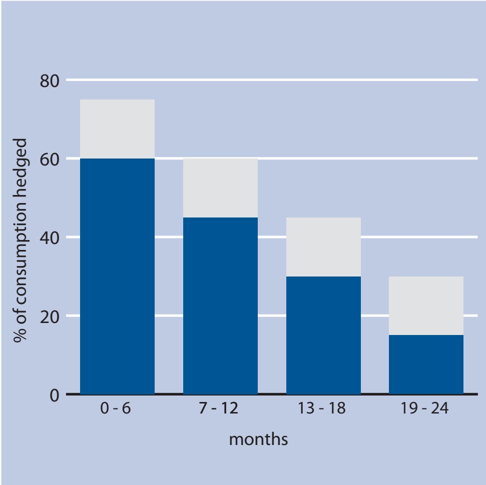
they come closer, i.e. minimum percentage cover is always adhered to, regardless of any personal view on the market. The higher percentage targets can be met if and when the government feels its risk tolerance, or market view, warrants it, i.e. some limited scope for personal view and opinion. The choice of instruments could also be different depending on the maturity, with call options for shorter maturities and call spreads and collars for longer maturities, noting that calls can get more expensive owing to the impact of time value.

4. Retain the flexibility to add or reduce hedges depending on market conditions, subject to the minimum percentage cover being reinstated in a relatively short timeframe.

Depending on market conditions, the government, after consulting with its advisers and market participants, should be able to determine

1. Tenor.

Figure 20.9: A rolling risk management strategy



Source: Morgan Stanley Commodities.

2. Hedge ratios.
3. Volumes to be hedged.
4. Instrument(s).

Internal risk management processes and procedures

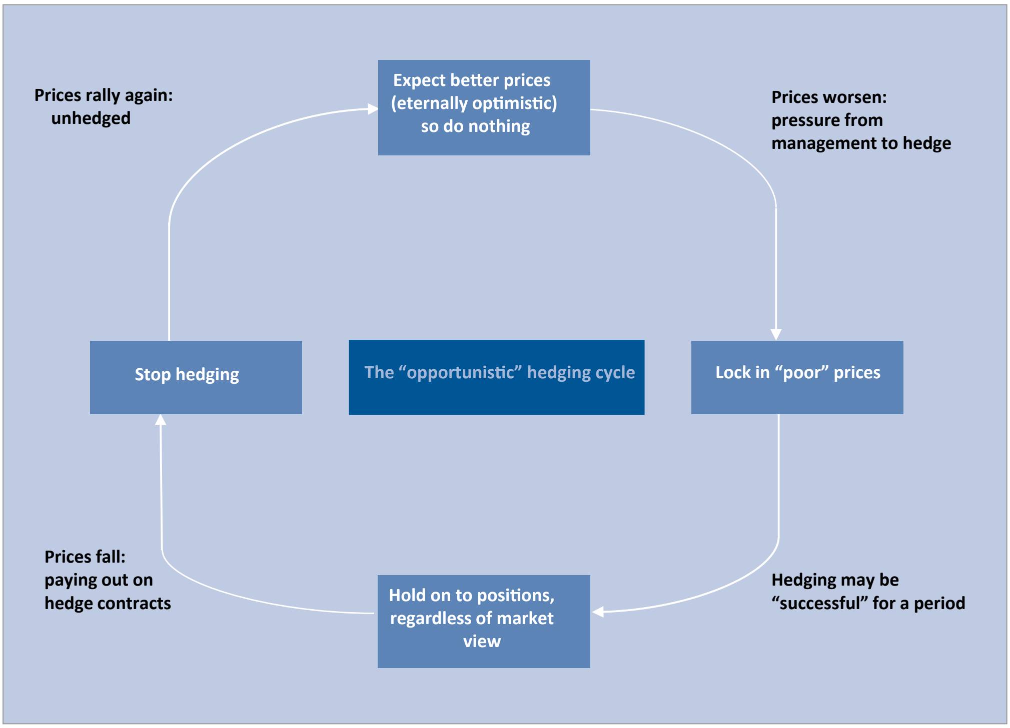
The experiences gained from previous government hedging initiatives and observed trends in corporate hedging behaviour have proven that a successful risk management programme is a strategic, systematic one.

In order to achieve this discipline, risk management should be executed under a clear policy set by the government (usually between the Ministries of Finance and Agriculture), determining the choice of instruments, tenor, volume, underlying commodities and so on. It should be executed by the hedge managers. The hedge managers have a duty to report the progress of the hedging strategy on a regular basis, requiring that they execute and monitor hedges routinely as set out in the strategy, regardless of their personal view or sentiment about the market.

This aspect is critical and stands at the centre of every successful hedging strategy. The purpose should be to externalize the risk and not to try to "beat the market". Personal or individual views on the market should not dictate the hedging process. That way, the government always has an adequate level of hedges for the period and with the instrument that they are comfortable with. This will preclude the "emotional" aspect that is illustrated in the Figure 20.10.

Communication is key in this process and will flow from the different hedging counterparties to the risk managers, providing them with market colour, pricing updates and ideas that should flow back to the Ministry to be considered in the larger hedging policy. The Ministry should also regularly interact with the hedge managers and give its guidance for the future hedges as illustrated in Figure 20.11.

Figure 20.10: A typical non-systematic hedging cycle



Source: Morgan Stanley Commodities.

Usually, these conversations are held on at least a monthly basis and include representatives of the ministry and the execution team to discuss recent hedging and the policy and strategy for future transactions.

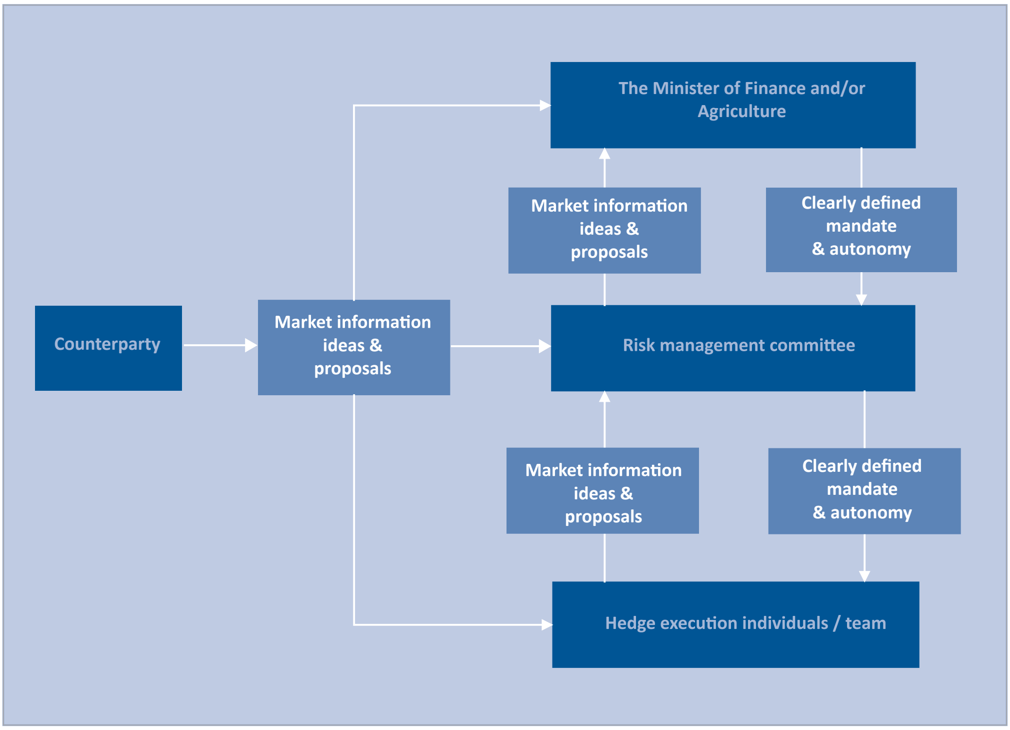
Choice of counterparty

The counterparty in a risk management programme needs to be selected carefully for various reasons. The first aspect is the credit worthiness of the counterparty as there will be an element of credit risk inherent in the use of derivatives, i.e. the ability of the counterparty to perform on its contractual obligations. The second key aspect is the experience and expertise in the given commodity market and the extent of the counterparty's involvement in that market as there will be times when meaningful risks need to be warehoused by the counterparty in order to ensure a smooth and efficient execution. Also important, especially for governments, is the counterparty's experience in dealing with corporations and governments that are new participants in the market and working with them to set up their risk management programme.

The counterparty will be a critical facilitator for the government in getting into the commodities market, with roles ranging from information dissemination to ensuring a transparent and efficient execution. The counterparty also provides assistance in establishing the risk management programme by sharing previous experiences.

In summary, as a non-exhaustive guide, the counterparty selected by the government

Figure 20.11: Organization structure in risk management



Source: Morgan Stanley Commodities.

should:

1. Be a strong credit-worthy institution, preferably rated at least A2 by Moody's or A by Standard and Poor's (S&P). Credit exposure limits can be set at pre-agreed levels with collateral arrangements in place beyond these limits. These credit arrangements are typically documented under a Credit Support Annex (CSA);
2. Have recognized experience in dealing with financial derivatives;
3. Have a broad knowledge and experience of the underlying commodity markets;
4. Have the relevant documentation in place with the government or relevant entity:

    (a) International Swaps and Derivatives Association (ISDA) Master Agreement

    (b) CSA, if relevant; and

5. Have proven experience of government hedging programmes.

The number of counterparties should be sufficient to ensure transparency and competitive pricing but still limited enough to avoid information spreading into the market and creating an "echo effect" that could distort the market and increase the government's cost of hedging. Typically, governments tend to have two to four selected counterparties with the ability to execute.

Conversely, banks would look for proof that the local jurisdictional framework allows for the use of these instruments and that the specific government entity leading the risk management effort is allowed to transact (i.e. has the required capacity and authority).

Execution

Before execution takes place, the government must set up the necessary documentation for trading commodity derivatives with its counterparties. The regulatory authorities insist that a certain level of client due diligence is carried out prior to engaging in business. The government will need to submit some organizational information to satisfy requirements before starting to transact. The counterparty must also perform a credit analysis and legal review of the jurisdiction in order to set the terms for the contractual documents that will govern the transactions. These transactions will normally be covered under an ISDA Master Agreement (which is the industry standard for derivatives) plus additional annexes (such as the CSA) that include any specific credit terms mutually agreed upon between the government and the counterparty.

Once the legal and documentation framework is set, the government can start executing trades with the counterparties that have been selected and set up.

The hedge manager will receive regular updates on market fundamentals, opportunities and pricing for the selected instruments.

Once the decision has been made to trade at a particular level, the hedge manager will request pricing from the different counterparties and select the best offer. The time between receiving indications and executing the trade needs to be extremely limited as the market keeps moving and indications can be void after a minute or less if the market is moving quickly.

The trade is then immediately agreed and the economics of the trade are recapped over the phone. These details include the type of instrument, the underlying commodity and reference price, the period, volume, pricing methodology (Asian or European), strike and premium. These form the contractual agreement of the operation. At this point of agreeing terms by telephone, the deal is complete and both parties are contractually obligated to the trade. Usually, the counterparty would additionally send an email after the transaction with the economics of the trade in writing as detailed above.

The full legal text confirmation is then sent within two days after the trade and needs to be signed and returned.

A dynamic approach

This approach recognizes that from time to time, and depending on market conditions, the government will want to reduce the hedging ratio and re-enter the market at a later stage. The government may also decide to accelerate the execution of its programme when the market presents an opportunity that fits its strategy.

Examples of recent government transactions in agricultural markets

In this section we outline a recent example of government involvement in the agricultural markets – a government of an emerging market country during the wheat price shock of 2007-08. At the time, the government did not have a hedging policy around its agricultural price risk, but felt it must take action to protect its increasing exposure owing to the wheat and bread subsidies in place for its domestic population.

The government therefore enacted an emergency hedging programme with the aim of covering 25–35 percent of its imports of wheat by buying call options referenced to the CBOT wheat market, which is the most liquid and transparent wheat index. The government was satisfied with the correlation of the CBOT wheat market to the market price it was paying on its physical contracts. The size of the programme was in excess of one million tonnes for one year, at a time when the liquidity was relatively poor. Therefore, the hedge was split into multiple smaller tranches (50 000 tonnes to 250 000 tonnes) that were executed gradually from the end of October 2007 to the end of January 2008, as the market price kept rising. The government received updates on prices and market conditions on a daily basis and decided to act regularly at the prevailing market price.

Once the programme was completed at the end of January 2008, the government kept monitoring its long call option positions and receiving regular updates from the counterparty. At the end of February, the market showed signs that the supply and demand tightness in the global wheat markets was easing. Therefore, the government decided to sell its position to monetize the intrinsic value in its hedge contracts (three times the amount of premium spent).

The market fell after February and throughout 2008 to reach a period of relative calm between 2008 and 2010. This same government has since then been working on a more structured and systematic hedging policy in order to have constant cover against all of its subsidies in its commodities exposure.

The above example has shown that acting regularly, even in a rising market, will have the benefit of entering the market at different levels and protecting against further rises. It also shows that allowing for flexibility and dynamic hedging (selling protection when the market is believed to be reaching a high in order to re-enter at a later and lower level) can have benefits. Although this hedging experience was a significant success, there is some degree of risk involved, as the selling or unwinding of the call option was based on a view on the market's evolution in the future. If that government had hedged regularly in advance, the benefit of the hedge would have been even greater as then the entry points would have been during the previous period of calm in 2006 to 2007.

More recently, there has been much media coverage on the hedging strategy of Mexico. This country is an interesting case as it is one of the first governments to have regularly hedged its revenues in oil – every year on similar volumes – in order to protect its budget.

Similarly, Mexico has put in place a hedging strategy to cover both its production and consumption of agricultural products. Its largest exposure is in its domestic consumption of white corn used in tortilla production.

According to the media, Mexico has hedged 4.2 million tonnes of its domestic consumption of corn in 2010[7] and is expected to hedge up to 6.4 million tonnes in the 2011/12 crop season.[8] The hedging is executed through ASERCA, a government agency reporting to the Ministry of Agriculture. Mexico has decided to use only options, buying call options on CBOT corn to cover its domestic consumption, for example. The budget to spend on risk management is set in advance and ASERCA executes on behalf of the government, within the budget and directions provided. The 2010 budget for the total agricultural commodity risk management programme is around USD 842 million, according to ASERCA's director of financial operations.[9]

7 Javier Blas, "Mexico hedges against corn inflation", 22 December 2010, Financial Times.

8 Carlos Manuel Rodriguez, "Mexico subsidizes 40 percent of corn hedging costs", 15 January 2011, Bloomberg.

9 Mica Rosenberg, "Mexico eyes new ideas for grains hedging", 22 December 2010, Commodities Now.

Key considerations

Market impact/liquidity

While commodity markets have developed substantially over the past three to five years, liquidity can still be a limiting factor in some markets.

Lack of depth in the forward markets could constrain large consumers or producers when they look to hedge a substantial portion of their consumption or production further down the curve (say, beyond six months to one year). Coming in to hedge (buy) large volumes could cause the adverse effect of pushing prices higher in a low liquidity environment.

This problem can be handled by carefully choosing counterparties that can warehouse the risk for some time and provide a sensible execution strategy based on their understanding of how much the market can absorb without being distorted.

Executing with a limited number of counterparties may be necessary to avoid the "echo effect" where different counterparties look for the same products and quantity while at the same time discussing it with brokers who then request it from other counterparties again. This could result in a transaction being perceived in the market as much larger than it actually is, thus pushing prices higher.

Basis risk

When hedging with derivatives, the basis risk is the risk that movements in the reference price in the derivative contract will vary from the price changes in the physical commodity being hedged. There are different elements that may cause basis risk:

- Product type: a government that is exposed to barley could be tempted to hedge its exposure with corn (owing to better liquidity), and therefore incur a basis risk between barley and corn price evolution;
- Product specifications: a company buying premium cotton and hedging it with the standard cotton, for example; and
- Geography: government buying wheat from various places in the world and hedging it with a single index like CBOT wheat.

The ultimate aim of a hedging programme is to minimize basis risk as much as practically possible if there is sufficient market liquidity.

Appropriate price indices should be chosen based on the best balance between basis risk and the liquidity of the chosen index. The chosen counterparty should be able to provide the necessary analysis to substantiate this decision.

In most cases, the government will have flexibility to decide where they source their physical commodity and will buy efficiently, i.e. from a relatively cheap source. Therefore, the choice of index cannot be made depending on where the physical commodity will be purchased (as this may be unknown at time of hedging), but rather by choosing an index that best reflects global fundamentals for the product, is transparent and liquid and correlates well with the physical exposure of the government over a period of six to twenty four months. Also, because the government would tend to buy from the cheapest source means that in a rising market, the reference price in the hedge contract is likely to outperform the physical purchase price. In this case, there will be a benefit of excess cash flow from the hedge contract compared with the negative cash flow on the physical purchase contract.

Political risk

Political risk refers to the personal and political implications on the career of individuals initiating and executing the risk management programme.

In most cases, the public would more readily accept the negative cash flows (budget deficits) arising from high prices than those arising from risk management decisions that failed to anticipate lower prices and therefore diverted resources from key development or budget needs into settling hedging contracts. This could provide political ammunition for opposition parties.

Although it is not easily quantifiable, political risk seems to be one of the key reasons that governments' hedging experiences have been, and continue to be, limited.

Critical steps must be taken to avoid such situations. The choice of instruments first must be adapted to the entity that will be hedging. If these are public organizations and the hedging is done at the governmental level, then option structures are probably the most appropriate. The liability is known in advance (is limited to the option premium) and can be budgeted as a form of "insurance" premium. Therefore, the government would still benefit from falling prices and negative perception would be minimized. Next, the internal set up should require a committee-based decision-making process, as opposed to just a few people being responsible. This committee should include members of the various departments and stakeholders involved. Finally, the transparency, discipline and regularity of the hedging would help avoid any allegations that a "view" has been taken. Instead, hedging would be seen as a step taken by the government for risk mitigation.

Physical supply issues: security of supply

Using commodity derivatives can reduce exposure to market volatility and externalize price risk.

However, these are cash settled instruments that are not related to the sourcing and supply of the physical commodity. Therefore, governments should always look at their risk management programmes in conjunction with an appropriate supply strategy.

As with the choice of risk management provider, it is essential to choose a supplier with a strong credit standing who will perform on their contracted obligations. Legal advice should also be sought regarding the procurement contract to ensure that it is as robust as possible so that potential supply disruptions are minimized.

Typically, it may be beneficial for the government to separate the suppliers of the physical commodity from the risk management products and services, as the physical players may not be as competitive on the derivative pricing.

In some cases, there is the potential for an integrated approach whereby the price risk management and physical supply are done simultaneously, i.e. they are integrated into the same contract from a single supplier. For example, buying forward physical wheat on an index (e.g. CBOT wheat) and agreeing on a maximum contract price (which would act like a call option). These solutions can be discussed and implemented with a reputable counterparty that has access and experience in both physical commodities and financial derivatives.

Conclusion

The numerous fundamental factors and emerging trends that characterize the agricultural markets today will likely result in an increasingly tight market vulnerable to supply shocks and subject to periods of volatility. Therefore, governments can no longer afford to ignore or postpone managing their agriculture price risk exposure.

In this chapter we have identified some key reasons why some governments have not historically employed the instruments and services available in derivatives markets to manage their risks. We have discussed at length an appropriate risk management solution – a systematic hedging programme that governments can adopt. We have also gone into some detail regarding the tools, strategies, processes and logistics that would typically underpin such a risk management programme, illustrated with practical examples.

While we acknowledge that a systematic and disciplined risk management process will not eradicate exposure to a sustained rising price environment, hopefully we have shown that it can help manage against shocks and thus facilitate governments' abilities to set their budgets more confidently and better manage their liabilities resulting from domestic food subsidies.

Chapter 21

The global grain contract: towards a new food security instrument

Ann Berg[1]

When futures markets sprung to life in Chicago about 150 years ago, no one could have envisaged how colossal they would become in the twenty-first century. Established as a clubhouse and insulated from public view, futures markets today have achieved celebrity status. Growing at remarkable rates for the past several years, these markets now attract interest from governments, the media, the financial world and the general public. However, outside the circle of professional users, futures markets in general are poorly understood and most recently have been lumped together with other sorts of "investments." This misunderstanding may be masking a potential beneficial role for futures in global price discovery.

How futures and securities differ

Futures contracts are unique instruments. Although various writers have recently classified futures as a type of security, from both a legal and operational viewpoint, they do not meet the securities designation. While securities - such as equity shares or bonds - are issued under strict legal standards by corporate or governmental entities, futures are purchase and sales agreements created by an exchange. Also, all securities offerings require United States Securities and Exchange Commission (SEC) registration (or other national supervisory body) and strict disclosure documents describing the issuing entity - *viz.*- business model, operations, financial results, management structure, etc. whereas futures contracts are filed with the United States Commodity Futures Trading Commission (CFTC) determines as a "Self Certification Submission." If the CFTC that the contract complies with the Commodity Exchange Act, particularly with regard to anti-manipulation provisions, it will allow the petitioning exchange to list the contract for trading.

Additionally, different regulations govern futures and securities. Most notably, rules prohibiting insider trading in securities do not apply to futures trading. As those inside a company play a fiduciary role to shareholders, they are prohibited from disclosing or trading on material non-public information regarding such matters as a takeovers or trade secrets. The concept of fiduciary does not pertain to commodity futures transactions - commodity traders possess varying amounts of information about crops or markets such as weather

1 Former director and trader at the Chicago Board of Trade and FAO consultant.

events, export sales, or government interventions, but there are no rules regulating the flow of such information. An exporter can disclose knowledge about potential export business or recent trading activity to anyone. Also many commodity related services publish daily reports on cash transactions and transportation rates. It is, however, illegal for a government official to leak knowledge of an official United States Department of Agriculture (USDA) crop report prior to its scheduled announcement.

The regulatory frameworks of securities and futures have many similarities, such as prohibitions against fraud, or front running, but otherwise have different objectives. Investor protection is the central aim of securities regulation, while preventing market manipulation is the intent of futures regulation. Both the exchange and the CFTC monitor the cash market and actively dissuade traders ("jawboning") from such practices as physical hoarding or non-economic movement of the commodity (distortion of trade). They also oversee the futures trading to guard against corners, squeezes or other price distorting activities.

Operationally, futures and securities differ sharply; futures contracts are hedging vehicles for the purpose of transferring risk - listed in serial months to suit hedging needs. Securities are investment instruments; equity securities represent a share of ownership in a corporation and bonds represent a creditor relationship between bondholder and issuer. In futures, speculators - i.e. traders that have no commercial interest in the underlying asset of the futures contract - hope to profit from taking the opposite side of hedgers' buy and sell orders. In securities markets, the securities buyer hopes to profit from share price increases, dividends or interest payments. In both markets, the speculator and the investor face risk of monetary loss, but from different circumstances. The speculator's loss arises solely from price risk exposure - which may be substantial. The investor's loss, which can stem from declining securities' prices, may arise also from debt default or bankruptcy of the issuing entity - the latter causing forfeiture of the entire investment.

Finally, while securities markets rely on a depository system to settle changes in ownership, futures markets interpose a central counterparty called the clearinghouse between every transaction. The clearinghouse - as the buyer to every seller and the seller to every buyer, relies on a margining system to eliminate the risk of default among market participants. To initiate trading, every clearing member must deposit with the clearinghouse an initial margin, which acts as a performance bond - usually equal to 5-10 percent of contract value. Because the clearinghouse "marks-to-market" members' trading positions, it collects and remits margin monies on a daily basis in accordance with the profit or loss on positions held or closed out. Significantly, gains and losses always offset each other and the number of buy and sell contracts always match. Hence, futures trading is called a zero sum game.

Futures contracts are standardized. For commodity contracts, the terms - usually called the specifications - will include underlying asset, contract size (by weight or volume), quality, currency denomination, minimum price fluctuation, delivery location or pricing basis and method of delivery or settlement. Other terms may include differentials for quality variations or for alternate delivery locations. In some contracts the final expiration price is cash settled, meaning that the price is derived from a formula of cash prices usually reported by reputable cash dealers. Maximum daily price limits and maximum position limits are also usually included in contract terms. Exchanges commonly create rules for dealing with potential price congestion or manipulation, default, and *force majeure* (Table 21.1).

In the United States of America, where commodity futures contracts have existed the longest, futures contracts originally were constructed by the major commercial players. Since the United States of America became a major exporter of wheat starting in the middle of the 19th century with Chicago as the primary storage and trans-shipment hub, the contracts were

Table 21.1: Securities versus futures

Securities	Commodity futures
Corporation/government issued	Exchange created
SEC registration	CFTC submission
Disclosure requirements	CEA compliance
Insider trading prohibition	Free information flow
Investor protections	Anti-manipulation provisions
Investment instruments	Risk transfer vehicles
Mostly collateralized	Highly leveraged
Intangible property	Commodity delivery obligations
Depository settlement system	Central clearinghouse
Capital formation	Zero sum game

meant to be most useful to warehouses which bought cheap cash wheat from the farmer at harvest and simultaneously sold a higher priced deferred futures month when shortages would likely arise. By doing so, the warehouse would "lock in" a profit that would more than offset its cost of storing and handling the grain. Because the warehouse controlled the stocks and the issuance of warehouse receipts - which became legal instruments in the state of Illinois in 1871 - it had considerable pricing power over the market. For example - only the warehouse with graded stocks (and therefore warehouse receipts) in its silos could establish a short futures position and then make delivery against the contract. Other short sellers would have to buy back their short positions, even if the futures price were a substantial premium to the physical commodity that could be brought alongside the elevator. In other words, farmers or grain operators would always take a discount to the futures price from the Chicago warehouse, as they had no way of turning their goods into registered warehouse receipts.[2]

Nonetheless, despite the power of the warehouse to control much of the delivery situation on the short side, long speculators could and often did acquire long positions exceeding the warehouse's abilities to accumulate grain and make delivery, especially in times of shortages (see Chapter 13). Corners and squeezes were a frequent event at the Chicago Board of Trade from its inception, sometimes involving the shipment of foreign wheat into the terminal area to break the corner. Finally, after WWI the Government of the United States of America put various measures in place to regulate and monitor the trading of futures contracts in agricultural commodities.

2 Under the Chicago delivery system, the warehouse would only "buy" and not "store" grain from farmers, wanting to keep control of grain stocks and delivery process. Grain silos outside the delivery market, however, allowed farmers to store grain by issuing farmers WHRs.

Mechanics of futures and hedging

As futures contracts approach expiration their prices begin to converge with underlying cash values, specified as the pricing basis of the contract. For example, the CBOT soybean contract specifies delivery of soybeans to be loaded into barges along the Illinois River. So, theoretically, the futures price will rise or decline to approximate the fob barge price during the delivery period. If futures prices are too high relative to cash, barge loading stations will tend to deliver against short futures sales, as the high futures price will represent a better price for their soybeans than the cash market. Conversely, if futures prices are too low relative to cash, long holders will tend to maintain their long positions to obtain the delivered commodity or until the price rises sufficiently to approximate cash values.

In the Chicago futures system, deliveries are tendered by the short to the clearinghouse which then assigns them to the long with the "oldest" purchase date. Although some futures contracts (such as the Zhengzhou cotton contract) permit the long to state some preference on quality or delivery locations with the clearinghouse, most futures contracts leave all options to the short. Hence, the least valued quality at the least desirable location will tend to be delivered first. Deliveries are tendered and stopped throughout the delivery month meaning that the same delivery instruments (in this case shipping certificates as opposed to warehouse receipts) can be "issued" and "stopped"[3] multiple times by multiple players as futures trading continues from the first day of the delivery month until mid-month. Other countries, such as India, do not allow retendering. There, after contract expiration, the clearinghouse compels the outstanding shorts to tender their deliveries which it then assigns to the outstanding longs. The delivery process is the key in bringing proper convergence between futures and cash - so that the basis level around the delivery market should be close to zero at contract expiration. For reasons discussed in Chapter 13, such as traders using delivery instruments as short term financing arrangements, convergence has become an imperfect process.

Hedging in commodity futures markets has been recognized as proper business activity from the market's inception. Well functioning future markets with ample long and short hedging orders tend to lessen volatility and reduce the trough to peak pricing inherent in the crop cycle. In markets without futures pricing, distressed harvest selling by farmers and end-of-year price spikes by end-users usually characterize price behaviour. Because commodities are volatile, the purpose of hedging is to diminish the price risk of a forward sale or purchase in the physical market. Futures can be thought of as proxy instruments to be held in place until the real transaction can occur: at this point, the hedger will offset the hedge by buying back its futures short or selling out its futures long.

Standard short hedge

Producers are standard short hedgers. After springtime crop sowing, the producer can sell a quantity of futures "short" against anticipated crop production. The sale will protect the producer against falling prices after the crop is harvested during fall. At harvest time, while making a cash market sale, the producer will buy back the hedge (same quantity/same contract month), thereby offsetting the trade. In the simplified example below ("zero" basis assumption), the producer anticipates a production of 50 000 bushels of corn - which is the equivalent of 10 futures contracts - 5 000 bushels each. In June, the producer decides to sell 10 December futures contracts at USD 5.00 and later, during November, buys back the futures at

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3 Issues and Stops are the standard terms exchanges use for making and taking of deliveries. The information is published daily during the delivery period.

Table 21.2: Standard short hedge example

Month	Cash harvest price (USD/bushel)	Dec Futures price (USD/bushel)
June	Harvest bid is 5.00	Sell 10 contracts of corn @ 5.00 (50 000 bushels)
November	Sell 50 000 bushels to elevator @ 4.00	Buy 10 contracts of corn @ 4.00
Difference	-1.00 (loss)	+1.00 (gain)
The cash sale of corn @ 4.00 is improved by futures gain of 1.00		Net price of corn realized = 5.00

Table 21.3: Standard long hedge example

Month	Cash price Jan/Feb (USD/bushel)	March Futures Price (USD/bushel)	Basis
September	Cash bid is 6.00	Buy 100 contracts of Wheat @ 6.75	-.75
January	Buy 500 000 cash wheat @ 5.00	Sell 100 contracts of wheat @ 5.25	-.25
Difference	+1.00 (gain)	-1.50 (loss)	.50
Cash purchase of wheat @ 5.00 incurred extra hedge cost of 1.50		Net price of wheat bought = 6.50	

USD 4.00 while selling the harvested production at USD 4.00. The producer realizes USD 5.00 per bushel for the sale. Whether the price increases or decreases, the producer would realize the same USD 5.00 for the grain by executing the USD 5.00 hedge.

Standard long hedger

Wheat millers are standard long hedgers. A wheat miller can protect against rising prices of wheat by buying futures contracts equal to its milling needs for a particular time period. In this example, the miller determines in September that it can profitably mill wheat into flour at the prevailing USD 6.00 per bushel January cash price and buys 100 contracts of wheat at USD 6.75 (minus USD 0.75 basis assumption). By January, the wheat price has dropped unexpectedly allowing the miller to buy cash wheat USD 1.00 lower, at USD 5.00. The basis level, however, has appreciated because farmers are reluctant to sell after the price drop and is now minus USD 0.25. After buying the USD 5.00 cash wheat, the miller sells out futures long hedge at USD 5.25, incurring a futures loss of USD 1.50. The miller’s cost of wheat is therefore USD 0.50 higher than the “locked in” price of USD 6.00 making the purchase price USD 6.50.

Table 21.4: Pitfalls of hedging example: soybeans		
Month	Cash harvest price (USD/bushel)	Nov Futures price (USD/bushel)
June	Harvest bid is 10.00	Sell 20 contracts of soybeans @ 10.00 (100 000 bushels)
October (harvest cut in half)	Sell 50,000 bushels to elevator @ 15.00 total proceeds = USD 750 000	Buy 20 contracts of soybeans @15.00 total futures loss = USD 500 000
Producer realizes total income return of USD 250 000 due to hedging and crop loss instead of projected USD 1 000 000		

Pitfalls of hedging

The standard hedges in the previous paragraphs in actual practice may turn out very differently depending upon developments in the crop year. The producer may only harvest half a crop for example, meaning that the loss incurred by buying back the hedge could dramatically diminish the proceeds from the cash sale. The following example illustrates the outcome of a producer using futures to hedge 100 000 bushels of soybean production at USD 10.00 - anticipating "locked in" revenue of USD 1 000 000 with devastating consequences when drought cuts harvest to 50 000 bushels (see Table 21.4).

In addition to quantity mismatches, other factors can undermine hedging strategies and execution.

Quality mismatch

The particular attributes of a commodity can make a significant difference in its value. For example, in 2008, wheat millers which hedged their needs for dark northern spring wheat[4] in the CBOT soft red winter contract, would have lost over USD 10 per bushel as DNS wheat traded as high as USD 25 while the Soft Red Winter (SRW) wheat contract reached USD 12.

Timing Mismatch Combined With Extreme Backwardation or Contango

In 1996, grain companies in the United States of America promoted a special type of hedging contract to producers called "hedge-to-arrive." Producers were urged to hedge expected harvest production in the July contract rather than the December because of the approximate USD 0.70 per bushel premium of the July over the December contract, a structure called "backwardation." For example, the July and December contract were trading around USD 3.70 and USD 3.00 respectively. The July hedge would eventually have to be "rolled" into the December to actually fix the cash price. As the crop year proceeded the July/December differential (called a "spread") widened substantially to about USD 1.60 - premium July. Producers that had to roll the July into the December (by buying back the July short and selling the December) incurred up to USD 1.60 per bushel loss in executing this strategy, cutting their cash price in half. A similar loss can occur when long hedgers need to roll hedges forward (selling spot and buying deferred contracts) and the market is configured in a steep contango - i.e. spot month is heavily discounted to deferred.

4 Dark Northern Spring wheat is the highest quality bread making wheat and is traded on the Minneapolis Grain Exchange. Soft red wheat is primarily used for crackers and cakes.

Basis Trading and Basis Risk

The 'basis', or the differential between cash and futures prices, is a common trading vehicle among commercial traders. The phenomenon of basis trading was first documented in the 1950s by Holbrooke Working. Taking issue with Keynes concept of natural backwardation,[5] Working proposed that hedgers used futures not as a risk aversion strategy but as a means of maximizing profits by trading the basis.[6] It is usually more predictable, especially for exporters with extensive logistical capacity and knowledge of global and regional supply and demand fundamentals. Theoretically, the basis cannot trade higher than the futures price plus the full cost of shipping the commodity to another site. If the basis approaches this value, then traders will simply buy the futures and use the deliveries as a source of cash to satisfy a short position elsewhere. For example, if the corn cash basis is trading at a USD 1.00 premium to the March futures for Gulf fob cargos for April shipment and the costs of barge shipment and fobbing the corn into a vessel is USD 0.95, then traders will sell the gulf basis and maintain a long March futures position until they receive delivery. This strategy can create considerable profit for a firm possessing shipping and fobbing capacity: as corn is drawn out of the delivery market, typically the futures price will rise; and, when the barge-loads of corn reach the gulf export market, the exporter can profit from both sides of the trade.

The basis, however, can present tremendous risk - particularly to a hedger, often called an "out of position" hedger. An out of position hedger is a trader long or short a commodity in a region that is distant from the price basis of the futures contract. For example, in 2007, if owners of wheat in the Black Sea region or South Asian[7] wheat growing regions sold CBOT futures as a hedge against that ownership, they would have incurred significant losses. As export taxes (or outright export bans) kept wheat prices in the region artificially low, the price of CBOT wheat tripled - from around USD 4.00 to USD 12.00. The CBOT price spike was a response to a global supply shock and an accompanying rise in demand for United States of America origin wheat. Because of the asymmetrical pricing between the two regions, the futures loss could not have been offset by gains in cash wheat ownership.

Another instance of problems associated with "out of position" hedging occurred in July 2010 on the Euronext-Liffe cocoa contract when a single hedge fund purportedly took delivery of virtually all of the cocoa tonnage in the delivery markets and sent the cocoa price to a record level. Because the delivery markets are in Northern European ports, such as Amsterdam, Antwerp and Hamburg, the growers of cocoa in the African countries of Côte d'Ivoire and Ghana could not sell futures against production and then make delivery to profit from the high price.[8] Indeed, any short in the July contract without registered delivery warehouse capacity was forced to buy back its short at a considerable loss. Unlike the CBOT wheat case, the price spike could be mostly attributed to the activities of a single player - after the July futures expired, the September futures dropped by almost 30 percent.

The section above demonstrates some basic drawbacks to futures trading and hedging in a globalized world: the playing field is asymmetric with large commercial players having

5 Keynes theorized that the futures price was usually lower than the spot cash price because short hedgers would pay an "insurance premium" to hedge long holdings and thus drive futures below the spot.

6 See Working (1953).

7 The Russian Federation, Kazakhstan, Ukraine, India and Pakistan are major wheat producing countries and, during years of bountiful crop production, tend to export significant quantities.

8 Similar to the early Chicago market, only the operators and owners of the warehouses can sell futures and make delivery via warehouse receipts.

tremendous advantage over small players. Also, for out of position players, hedging can be disastrous. Many countries have understood the hazards and complexities of international futures trading and have encouraged the establishment domestic markets - both cash and futures - to aid producers, processors and users in commodity risk management.

Domestic initiatives have been extremely successful in helping the producer side of the market. Many recent studies have demonstrated how futures have aided producer income realization, by reducing distressed selling, facilitating credit, offering marketing choices, and rewarding quality production. However, government policy constrains most domestic markets. The Government of India for example halted trading in several basic food commodities after perceiving inflation in wheat, tur, dal, potatoes and sugar.[9] The Government of China has frequently intervened in futures markets. Consequently, futures in emerging markets have limited suitability for international hedging and in some cases (e.g. India) foreign direct investment is prohibited. On the opposite side of the supply chain, import dependent countries have almost no instruments to manage commodity price risk outside the international markets such as the CBOT and more recently the Euronext Liffe, where the milling wheat, corn and rapeseed contracts have been gaining benchmark status rapidly. Perhaps now is the time to explore new instruments for addressing the consumption side of the market.

Global contracts

Because of their unique attributes, futures contracts are open to a wide range of design options. Past futures contract creation favoured warehouses and commercial exporters. With few exceptions,[10] these contracts were based on a single country of origin. The large international exchanges could, however, construct global contracts for cereal and oilseed markets that would complement their current product offerings. Instead of tracking prices that converge with cash values in a single geographic area, global contracts could track "cheapest to deliver" commodities by designating delivery points all over the world. As noted previously, commodities of least value are the ones tendered first by the short. This means, for example, that traders in countries with comparative surpluses and hence low relative prices would deliver on the futures. These deliveries would set the price of the contract.

A precedent for global contracts in the commodity futures market does exist: both the InterContinental Exchange and Euronext Liffe list a global sugar futures contract. The Euronext Liffe contract - based on white sugar - specifies delivery fob vessel in over three dozen countries. The exchanges designed the contracts as such because of the international structure of sugar production, including its staggered hemispheric growths. The ports able to originate the cheapest sugar (with respect to contract differentials) are the first to deliver against the contract. This unique delivery system is a global signalling system of both price and regional supply availabilities - ready for export, unlike interior based delivery systems that are centred in one geographic location. In addition, such a contract would tend to better absorb events such as export bans or export taxes declared by some countries, as it would spread the price impact of a supply or demand shock across all potential exporting countries.

9 These markets have been restarted.

10 The Tokyo Grain Exchange corn contract was the first grain contract to specify CIF delivery to a foreign destination - in this case Japanese ports. The contract is also denominated in Japanese Yen and not United States Dollars.

A global fob contract does have a drawback to potential long takers: the uncertainty of delivery location makes logistical planning - including vessel chartering - complicated and more costly than standard futures. However, this type of drawback may be a perfect antidote to the financialization of futures that has characterized futures markets in the United States of America, evidenced by the build-up of speculative long positions reported in the CFTC Commitment of Traders. Because the delivery-taker would need to charter a vessel and execute a *bona fide* sale to another country, the contract would maintain its integrity to the cash market.

A case for wheat

A global fob wheat contract that would specify fob delivery points in the major producing regions such Australia, Argentina, the Black Sea region, Canada, France and the United States of America would be the most logical initial contract to develop for either cereals or oilseeds. Wheat has multiple origination possibilities and is the most basic food grain shipped in international markets. The contract could also contain contract terms to attract speculators but ensure ultimately that the wheat was channelled into proper commercial channels. In fact, such a contract would attract speculators that arbitrage between two markets in the same commodity (e.g. long French wheat/short global wheat). Arbitragers play an important role in reducing volatility and creating price efficiency.

These terms could include:

- Delivery every other month - or alternatively every month to ensure proper convergence with the cash market throughout the year
- Compulsory load-out by the long taker within 60 days of receiving notice of delivery. Compulsory load-out is a feature of Indian futures markets and prevents stocks accumulation by speculators who keep the commodity insulated from commercial channels
- Speculative position limits which are the same for every month, e.g. 1 000 January, 1 000, March, 1 000 May, etc. This would prevent the distorting “roll” before every delivery month
- Contract size denominated in 100 tonnes
- Delivery quantity issued by load-out elevator in multiples of 5 000 tonnes
- Quality to include both hard red wheat and white wheat at differentials

The currency denomination of this contract could involve a hybrid approach of trading in dollars and calculated simultaneously in Special Drawing Rights (SDRs), which are international currency reserve assets issued by International Monetary Fund. SDRs are not a currency *per se* but rather a currency derivative. The SDR value is the reciprocal of the sum of the weighted basket of four currencies (quoted in exchange rate equivalents): the British Pound, the Euro, the Japanese Yen and the United States Dollar. It is recalculated every day (see chart below). Although intended help countries with reserve issues, SDRs have received endorsement by several economists, notably World Bank President Robert Zoellick, as a possible basis for a new monetary system. Officials in China have also proposed the development of a new monetary system based on SDRs. Finally the IMF in December of 2010 has urged the transition from a single reserve currency (United States Dollar) to SDRs. Although it is doubtful that either SDRs or another currency such as the Euro would start to denominate commodities in the immediate future, a double quote system would offer an alternate pricing view, particularly as many countries that draw on SDRs are commodity importers.

Because SDRs are calculated as a reciprocal to non-United States Dollar currencies - they could provide a price mechanism that smoothes out the volatility of United States Dollar

Table 21.5: IMF calculation of SDR value				
As of Monday, 20 December 2010				
Currency	Currency amount under Rule O-1	Exchange rate [1]	USD equivalent	Percent change in exchange rate against USD from previous calculation
Euro	0.4100	1.31640	0.539724	-0.829
Japanese yen	18.4000	83.79000	0.219597	0.322
Pound sterling	0.0903	1.55590	0.140498	-0.071
USD	0.6320	1.00000	0.632000	
			1.531819	
USD 1.00 = SDR			0.652819 [2]	0.255 [3]
SDR1 = USD			1.53182 [4]	

[Note: To obtain the SDR value – multiply the currency amount (column 1) times the exchange rate (column 2) and add the results (column 3). The sum - 1.531819 (row 5) is divided into 1 to achieve the reciprocal SDR value of .652819.]
source: http://www.imf.org/external/np/fin/data/rms_sdrv.aspx
(1) The exchange rate for the Japanese Yen is expressed in terms of currency units per United States Dollar; other rates are expressed as United States Dollars per currency unit.
(2) IMF Rule O-2(a) defines the value of the United States Dollar in terms of the SDR as the reciprocal of the sum of the equivalents in United States Dollars of the amounts of the currencies in the SDR basket, rounded to six significant digits. Each United States Dollar equivalent is calculated on the basis of the middle rate between the buying and selling exchange rates at noon in the London market. If the exchange rate for any currency cannot be obtained from the London Market, the rate shall be the middle rate between the buying and selling exchange rates at noon in the New York market or, if not available there, the rate shall be determined on the basis of Euro reference rates published by the European Central Bank.
(3) Percent change in value of one United States Dollar in terms of SDRs from previous calculation.
(4) The reciprocal of the value of the United States Dollar in terms of the SDR, rounded to six significant digits.

based commodities - which tend to rise when the United States Dollar declines. While the United States Dollar value is always held constant as an exchange rate of 1:1, the other three currency exchange rates are computed against the United States Dollar (see IMF notes below chart). If, for example using the chart below, the Euro exchange rate were revalued at 2.00 instead of 1.31 (meaning that the United States Dollar was considerably weaker), then the SDR value would be recomputed (rounded to two digits) from 0.65 at 0.55. If United States Dollar based commodities rose or fell based on weakness or strength, the SDR value would move in opposite direction of commodity price. For example, a wheat price of USD 300 per tonne would be calculated at around 196 SDRs with the SDR rate at 0.65. If wheat rose to USD 360 per tonne and the SDR rate fell to 0.55 due to a weaker United States Dollar, then wheat would be only slightly higher in SDRs - or 198 SDRs.

Conclusions

In sum, the world needs greater understanding of the characteristics, role and possibilities of futures markets in today's globalized environment. Although futures markets have experienced phenomenal growth worldwide over the past ten years, the current system appears insufficient to serve "out of position hedgers" (long cash/short futures) and commodity importers (short cash/long futures). A global contract with multiple delivery ports containing safeguards against excessive speculation and assurances of commercial viability could help remedy the current market shortcomings. A hybrid quote system of dollars and SDRs could prove to be an interesting test case for commodity pricing.

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Chapter 22

Strengthening global food market monitoring

Jim Greenfield and Abdolreza Abbassian[1]

I cannot tell you how many thousands of times I have traded on information that 24 hours later proved to be at least partially inaccurate or irrelevant. (Paul Tudor Jones, hedge fund manager.[2])

The setting

Sharp price rises of basic food commodities on world markets in recent years have been the subject of intense interest and concern on the part of consumers and importers everywhere. Doubts have been voiced about whether international markets can be relied upon to meet importing countries' needs, and, for this reason, there is concern over food security implications. This is part of the wider issue of price volatility that has been the subject of earlier chapters in this book, where the effects of sharp price declines for producers have been examined. Yet, over the long-run, periods of high world prices have been less frequent than declines – roughly one year in four in the case of cereals, and something similar in the case of oilseeds, oils and meals. This helps to explain why the bulk of both international and national efforts have been directed at addressing problems of low, rather than high, prices. Thus, over the years, enormous sums have been spent on buttressing farm incomes largely in richer countries, while far smaller sums on keeping consumer prices at accessible levels mainly in poorer countries. Reflecting this imbalance, most of the trade liberalization negotiations have focussed on reducing and constraining support to producers. Liberalization was widely expected to lower price variability even though, at the same time, a reduction in carryovers was also expected, which on its own would act to increase price variability.

Over the past few decades, international efforts to tackle price volatility focused on two main approaches:

- the attempt to negotiate international commodity agreements to stabilize prices, which saw the greatest thrust in the 1970s, after which they have been rather low-key; and
- the development of various compensatory financing arrangements, that is the International Monetary Fund's Compensatory Financing Facility (CFF) – which have provided some help to eligible countries, but nothing in any way comparable to producer support in many Organisation for Economic Co-operation and Development (OECD) countries.

1 Jim Greenfield, former director of the Commodities and Trade Division (FAO) and Abdolreza Abbassian, Trade and Markets Division (FAO). The authors express their sincere thanks to Concepción Calpe and Peter Thoenes for their valuable comments and suggestions.

2 Interview in Financial Times (2010b).

Currently, there is growing interest in the methods that might be used to limit the impact of non-commercial financial sector investment in futures contracts for food commodities, a subject discussed in Chapter 13. Whatever the merits of current proposals, it is clear that this type of approach could affect price volatility and perhaps serve to reduce extreme fluctuations. In this sense, moves to regulate futures markets are akin to the earlier approaches to international commodity agreements that operated on the physical volumes traded so as to help stabilize prices in the market.

The basic causes of periods of sharply rising market prices have varied somewhat over the years.

In the mid-1970s, during the world food crisis, grain stocks had been very low, prices of petroleum and inputs had been rising beforehand, when a sharp rise in import demand by the former USSR sent grains prices soaring. In the case of rice stocks, which were also low, a very thin world market was not able to handle the sudden surge in import demand that followed a poor monsoon that afflicted the rice-growing belt of South Asia. Some exporters introduced export taxes, and there was a brief export ban on oilseeds by the world's largest exporter, the United States of America.

In the mid-1990s, while stocks had been run down as part of the policy to curb public support of agriculture during the liberalization process, the deterioration of the global supply/demand situation caused world prices to soar.

In the 2008-2010 double-spike of cereals and oilseeds prices, which also affected livestock and dairy products, the main causes were the low level of exportable supplies in a period of rising utilization (in part owing to sharply increased use of grains and oil crops as biofuel, as well as a welcome rise in consumption in some rapidly expanding developing economies, particularly in Asia). For some cereals and oilseeds, the spikes were aggravated by substantial purchases of futures contracts by non-commercial agents and by national trade policies, including temporary export bans that limited the market response of a number of countries.

In 2010 there was an unexpected weather-driven drop in grain production in some key exporting countries together with restrictions on exports by some.

Growing demand for more accurate and timely market information

In September 2010, the one-day Extraordinary Intersessional Meeting of the FAO's Intergovernmental Group (IGG) on Grains and Rice noted that among the root causes of recent price volatility was the lack of reliable and up-to-date information on crop supply and demand and export availability. Therefore, the IGG recommended that the FAO intensify its information gathering and dissemination at all levels (FAO, 2010). While this recommendation was addressed to the cereals sector, there is little doubt that the same can be said of the other major foodstuffs too. The problem is widespread. Despite the increase in the volume of raw data and the greater speed of transmitting information over recent years, the capacity to analyse the mass of often conflicting and variable quality data and to disseminate the resulting analyses has not kept pace particularly in the public, free-access sector.

The notion of the price system as an information entity is alluded to extensively throughout this volume. Chapter 14, for instance, highlights the role of information in expectations formation and its consequence on price determination. It was shown that "uninformed trade" may accentuate price movements to the extent that if the number of uninformed traders dominate those who are informed, "price bubbles" could be generated. Information also plays an important role in determining the behavioural dimensions of markets. Traders' inability to give proper weight and context in processing new information may lead to an over or under-reaction in price response. Therefore, a corollary of enhancing information provision in the public domain would be to improve the efficiency of the price system.

At the national level, the capacity of many countries to collect and process basic agricultural data has often deteriorated, and public statistical services have difficulties undertaking such forward-looking exercises as crop forecasts, let alone comprehensive supply/demand analysis and trade forecasts. The IGGs recognized this weakness and recommended action to strengthen capacity of all partners "in relation to monitoring planting intensions, crop development and domestic market information". As one of the partners, FAO was also requested to improve its own contribution.

The approach that FAO is pursuing in order to enhance its global monitoring activity is based on the fact that the bulk of world production, consumption, stocks and trade is accounted for by a relatively limited number of countries. A significant improvement in the ability to monitor world food markets will necessarily involve making improvements to this key set of major country/commodity elements. As shown in Tables 22.1 to 22.4, for such important food crops as rice, wheat, coarse grains and soybeans, access to accurate information on production in a few countries can go a long way in helping to understand market trends at the global level. For instance, in the case of wheat and rice, less than ten countries account for over 90 percent of world production. Good information on these countries would alone make for a much-improved picture of the global situation. Of course, it is always desirable to strengthen food monitoring for all countries, but it is felt that the most efficient way to respond to the type of requirements listed by FAO's IGGs is to focus on the main market movers.[3]

Regarding the quality of the short-run supply/demand assessments, information on all of these markets movers has strong points as well as weak ones. Some historical databases, on which forecasts are necessarily founded, are weak; others have highly variable weather patterns, or rely on rain-fed production which makes monitoring particularly difficult; some simply don't publish information on key variables; and others are vast countries with many different crop seasons that make aggregation difficult. In addition, across crops, planting and harvesting periods are often very different in most countries. As illustrated in Table 22.5, given a limited potential for expanding total agricultural land in the short-run, changes in plantings of one crop can influence the size of land dedicated to other crops, which is another important factor that will require closer monitoring.

In the sections below, we suggest how to improve monitoring systems. The list is illustrative and analysts will have to develop detailed plans to improve assessments country-by-country and commodity-by-commodity.

Production forecasts

It is evident that production forecasts remain at the centre of world food market assessments.[4] Though it has been long perceived to be the main cause of variations in supply and demand

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[3] In fact, most other countries are covered by the FAO's Global Information and Early Warning System (GIEWS), which has been recognized internationally as having a comparative advantage in making food assessments in food deficit developing countries. The FAO-GIEWS already works closely with the other major agencies involved – the World Food Programme (WFP) as well as other UN agencies and government and non-government organizations – and since its inception in late 1970s has built up in-depth country databases especially for cereals.

[4] Although, as will be discussed later, there are also significant sources of uncertainty with consumption, stocks and trade.

Table 22.1: Wheat: leading producers and their global share

Wheat production: leading producers and their global share		
Country	Production (2008-2010 average)	Global share
	(million tonnes)	*(percent)*
EU	141.5	21.0
China (Mainland)	114.2	17.0
India	80.0	11.9
United States of America	62.8	9.3
Russian Federation	56.2	8.3
Canada	26.2	3.9
Australia	23.4	3.5
Pakistan	23.0	3.4
Ukraine	20.8	3.1
Turkey	19.3	2.9
Kazakhstan	15.0	2.2
Iran Islamic Rep. of	12.4	1.8
Argentina	9.1	1.4
Egypt	8.4	1.2
Uzbekistan	6.5	1.0
Other countries	54.5	8.1
World	673.2	

balances, rarely has this been so evident as in 2010 when grain production was hit by unexpected weather shocks in several major producing regions almost simultaneously. Moreover, with an increasing proportion of world grain supplies originating from the Black Sea region,[5] an area known for its large variations in yields, unexpected production variations are likely to emerge as a more common feature rather than an exception in the years to come.

In the few months prior to the 2010 price surge, international and national agencies were expecting bumper crops and a generally favourable supply outlook world-wide for the 2010/11 marketing season. The drought-reduced production in the Russian Federation coupled with reduced harvests (also weather related) in other major Commonwealth of Independent States (CIS) producing countries, as well as in Canada and in the European Union, changed the outlook considerably. Events in the Russian Federation, which included repeated downward revisions to production forecasts and the subsequent ban on exports, acted as a leading catalyst for the surge in world price of major grains between late July and mid-August 2010. Given the country's growing importance as a major grain supplier to world markets (the world's fourth largest wheat exporter in 2009/10), a sudden substantial cut in its production or exports was bound to have a major bearing on world markets, as it did in 2010.

Although the first official indication of a major fall in 2010 grain production in the Russian Federation appeared in late July (i.e. few weeks before the harvest), many private agents, both inside and outside the country, were forecasting a fall in output from April. In retrospect it seems that private forecasters were monitoring crop conditions in major growing

5 The major CIS exporting countries accounted for almost 30 percent of the global wheat trade in 2009 as compared with only 4 percent in 2000.

Table 22.2: Rice: leading producers and their global share

Rice production: leading producers and their global share		
Country	Production (2008-2010 average)	Global share
	(million tonnes)	*(percent)*
China (Mainland)	194.5	28.2
India	143.1	20.8
Indonesia	63.6	9.2
Bangladesh	48.5	7.0
Viet Nam	39.2	5.7
Thailand	31.4	4.6
Myanmar	30.8	4.5
Philippines	16.5	2.4
Brazil	12.0	1.7
Japan	10.8	1.6
United States	10.1	1.5
Pakistan	8.9	1.3
Cambodia	7.6	1.1
Korea Rep. of	6.4	0.9
Egypt	5.8	0.8
Other countries	60.0	8.7
World	689.2	

areas more closely than the public authorities. Because the FAO based its production forecasts for major producing countries on official sources, its earlier forecasts for grain production in the Russian Federation were too high and had to be revised down sharply several times, as shown in Figure 22.1.

A similar situation emerged in the United States of America, this time with regard to maize production. The United States of America is the world's largest producer, user and exporter of maize. For this reason, the maize supply and demand balance in the United States of America has a major impact on world maize markets. The early expectation for the 2010 maize crop in the United States of America pointed to an increase in output (from 2009) to a near record level. Instead, as the season progressed, unfavourable weather conditions (too much rain) hampered yields, reduced production prospects and eventually resulted in maize production falling below the 2009 level. In spite of unfavourable weather conditions during the growing season, the official forecast for maize production in 2010 remained high until very near the harvest. Only in early October (i.e. one month before the harvesting period) crop forecasts were revised sharply lower by the United States Department of Agriculture (USDA) in their World Agricultural Supply and Demand Estimates (WASDE) report of October 2010. This late revision contrasted with expectations of private agents, such as traders, investment firms and banks, who were forecasting lower yields (and hence lower production) from August onward. In most cases, private agents utilized the official area estimates[6] published by the USDA but based their production forecasts on their own yield surveys and field observations. For example, a leading trading house reported that its "early and accurate read

6 The estimates were derived from an extensive survey of maize growers by the USDA, which is usually carried out every year in early June.

Table 22.3: Coarse grains: leading producers and their global share

Coarse grains production: leading producers and their global share		
Country	Production (2008-2010 average)	Global share
	(million tonnes)	*(percent)*
United States of America	336.2	29.9
China (Mainland)	174.8	15.5
EU	153.1	13.6
Brazil	57.7	5.1
India	37.2	3.3
Russian Federation	31.6	2.8
Mexico	30.4	2.7
Canada	24.1	2.1
Argentina	24.1	2.1
Ukraine	23.0	2.0
Nigeria	21.7	1.9
Indonesia	17.3	1.5
Australia	13.6	1.2
South Africa	13.4	1.2
Ethiopia	12.8	1.1
Other countries	154.6	13.7
World	1 125.4	

Table 22.4: Soybeans: leading producers and their global share

Soybean production: leading producers and their global share		
Country	Production (2008-2010 average)	Global share
	(million tonnes)	*(percent)*
United States of America	81.7	35.4
Brazil	62.0	26.9
Argentina	44.2	19.2
China	14.4	6.2
India	8.8	3.8
Paraguay	6.2	2.7
Canada	3.2	1.4
Bolivia (Plurinational State of)	1.5	0.7
Uruguay	1.3	0.6
Other countries	7.4	3.0
World	230.7	

Table 22.5: Planting and harvesting periods for major crops in leading agricultural markets

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Country % share in: World production	Country % share in: World exports	Crop % share in: total domestic arable land
Argentina															
Wheat													2.2	8.2	19.7
Maize													2.6	15.1	8.7
Sorghum													4.5	8.6	1.8
Soybeans													17.2	31.0	47.7
Sunflower													12.6	30.0	7.1
Sugarcane													1.4	0.9	1.0
Australia															
Wheat													2.8	11.7	27.1
Barley													4.6	19.3	9.5
Sorghum													2.7	2.2	1.5
Cotton													1.6	6.0	0.5
Rapeseed													3.6	4.0	2.4
Brazil															
Wheat													0.6	0.2	4.4
Maize													5.9	5.6	20.8
Rice													1.9	0.8	6.1
Cotton													4.6	2.0	1.8
Soybeans													25.2	31.0	35.5
Sugarcane													31.2	39.5	9.5

Table 22.5: Planting and harvesting periods for major crops in leading agricultural markets (continued)

Canada															
Wheat													4.0	14.8	22.0
Maize													1.3	0.3	2.5
Barley													8.1	11.9	9.0
Rapeseed													18.5	67.0	11.5
Soybeans													1.4	1.0	2.5
China															
Wheat													16.9	1.5	15.6
Maize													19.8	4.9	17.8
Barley													2.6	0.0	0.6
Sorghum													4.2	0.4	0.4
Oats													2.7	0.0	0.2
Rice													29.5	4.6	19.8
Cotton													27.6	4.0	3.7
Rapeseed													28.2	1.0	5.1
Soybeans													8.2	1.0	6.7
Sunflower													6.1	1.0	0.7
Sugarbeet													2.7	0.2	0.2
Sugarcane													6.8	0.5	1.0

Table 22.5: Planting and harvesting periods for major crops in leading agricultural markets (continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Country % share in: World production	Country % share in: World exports	Crop % share in: Total domestic arable land
EU-27															
Wheat													20.0	11.5	23.2
Maize													6.6	0.2	8.6
Barley													39.6	21.4	12.5
Oats													32.7	8.4	2.7
Rapeseed													31.3	2.0	4.2
Sunflowwer													23.	7.0	3.5
Sugar beets													53.4	76.9	2.0
India															
Wheat													11.6	0.4	16.3
Maize													2.0	0.3	4.5
Sorghum													12.6	0.4	5.8
Rice													21.7	15.0	26.3
Cotton													13.8	0.0	5.3
Rapeseed													12.9	11.0	3.6
Soybeans													3.2	4.0	4.2
Sunflower													3.6	0.0	1.2
Sugar cane													19.1	1.3	2.5
Indonesia															
Maize													1.7	0.1	14.8

Table 22.5: Planting and harvesting periods for major crops in leading agricultural markets (continued)

Rice	8.1	0.0	51.0
Soybeans	0.4	0.0	2.5
Sugar cane	2.1	0.5	1.9
Mexico			
Wheat	0.5	0.4	2.4
Maize	3.0	0.0	29.3
Sorghum	9.0	0.0	7.3
Sugar cane	3.5	1.4	2.6
Russia			
Wheat	7.6	9.7	18.5
Barley	12.2	10.1	7.5
Oats	19.5	0.0	2.6
Sunflower	19.2	14.0	4.1
Sugarbeets	8.6	1.7	0.7
South Africa			
Wheat	0.3	0.2	5.4
Maize	1.2	1.3	22.7
Sunflower	2.4	0.0	3.6
Sugar cane	1.5	2.9	2.9
Ukraine			
Wheat	2.6	3.7	14.9
Maize	0.9	1.8	6.1
Barley	6.4	26.1	13.8
Oats	3.0	1.0	1.5
Sunflower	14.3	35.0	11.2
Sugarbeets	6.2	2.2	2.0

Table 22.5: Planting and harvesting periods for major crops in leading agricultural markets (continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Country % share in: World production	Country % share in: World exports	Crop % share in: total domestic arable land
USA															
Wheat				Planting	Planting	Harvesting	Harvesting	Harvesting	Planting and harvesting	Planting	Planting		9.0	24.3	11.8
Maize				Planting	Planting					Harvesting	Harvesting		40.4	63.6	16.9
Barley				Planting	Planting			Harvesting	Harvesting				3.2	2.9	0.9
Sorghum				Planting	Planting	Planting				Harvesting	Harvesting		16.2	72.2	1.5
Oats			Planting	Planting			Harvesting	Harvesting					6.2	1.5	0.4
Rice				Planting	Planting				Harvesting	Harvesting			1.5	10.8	0.7
Cotton			Planting	Planting	Planting					Harvesting	Harvesting	Harvesting	17.4	29.0	3.0
Rapeseed			Planting	Planting			Harvesting	Harvesting	Harvesting				1.6	3.0	0.2
Soybeans					Planting	Planting				Harvesting	Harvesting		38.8	27.0	17.0
Sunflower					Planting	Planting				Harvesting	Harvesting		4.7	3.0	0.5
Sugarbeets				Planting	Planting				Harvesting	Harvesting	Harvesting		11.0	2.2	0.3
Sugar cane	Planting and harvesting	Planting and harvesting	Planting and harvesting	Planting and harvesting						Planting and harvesting	Planting and harvesting	Planting and harvesting	2.1	0.7	0.2

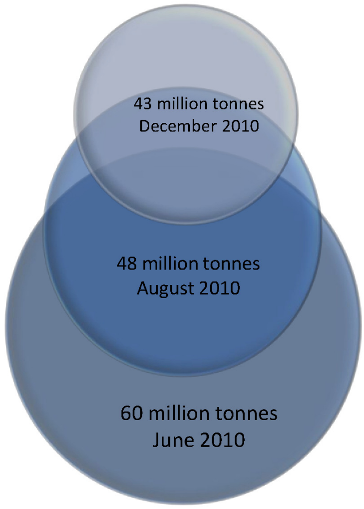
Planting

Harvesting

Planting and harvesting contemporaneously

Note: The tables highlight the main periods with regard to the planting and harvesting of the most relevant agricultural crops at a highly aggregated level. This list does not intend to be exhaustive. The compiled information is based on the last five years. Tables are reproduced from Food Outlook, November 2007.

Figure 22.1: FAO's production forecasts for 2010 wheat crops in the Russian Federation



on the weather, such as a drought in Russia" in the summer 2010 allowed it to anticipate lower crop yields and position its trading strategy accordingly. This resulted in boosting its profit margin and earnings that year (Financial Times, 2010a).

Improved production forecasts

Traditionally, production forecasts are made up of separate forecasts of area and yield. The area planted to an annual crop results from the translation of earlier planting intentions and developments at the outset of the planting period such as delayed rains – a common problem in non-irrigated agriculture and illustrated every year in the time of arrival of the southwest monsoon. Planting intensions are published officially for some crops and by some countries, but by no means for all of them and sometimes the quality of these reports leaves much to be desired.

Private traders have a special interest in production forecasts, and many either circulate their assessments to subscribers to their newsletters or, if contacted, are prepared to share their views with other analysts, often during trade conferences or trade fairs. Subscribing to newsletters, exchanging views and estimates with the private sector and/or attending meetings of traders is a valuable way of supplementing official announcements of planting intensions. Another approach is to arrange for a local consultant to prepare an annual report on the outlook early in the season in each of the key countries. The person should be someone with experience of the sector and with knowledge of the government officers at the Ministry of Agriculture.

For perennial tree crops (palm, olive and coconut), the main factor is not only the area covered, but also the age structure of the trees: the same trees as the year before will have a different potential output because yield varies with the age of the tree. The stock of productive trees can be raised by planting out young trees from nurseries, but this is usually a relatively small factor. Supporting periodic censuses of tree stocks is a great help to making more accurate output forecasts. Indeed, the improvement of baseline production and area data for all crops annuals and perennials is always of use in improving production outlook work. In cases where part of the problem lies with the data for recent years, one of the strategies could well be the mounting of specialized statistical missions to improve local capacity, undertake censuses and generally improve forecasting ability locally.

The area planted lends itself to model building, and huge numbers of agricultural supply studies have been undertaken over the years. Where suitable studies are available, they can be used to make short-run forecasts of area planted. But a word of caution is needed regarding the use of "off-the-peg" models. They have usually been developed with a different purpose from area forecasting – either for long-term projections, policy modelling or for welfare analyses. Rarely will they be easy to "calibrate" to current levels of production and price. It is usually advisable to construct a relatively simple model tailored to answering the immediate needs of short-run forecasting. This type of model needs to include expected prices of the crop concerned, together with prices of the main competing crop(s) and input costs. It should reflect current policy decisions on, for example, government procurement policies, water allocation decisions and input subsidy programmes.

In addition, high and volatile prices of nearly all major food crops, as experienced in recent years, make advance estimation of the eventual size of plantings more difficult. To most farmers, a higher price of one crop is a reason to plant more of that crop. The other reason is the general anticipation that even if prices were to decline, the decrease could be less than those of the other competing crop(s). In other words, farmers normally make their planting decisions based on relative profitability between among crops. However, in countries where several crops with often similar planting periods are grown, farmers may find it less risky to expand production of not one crop but a combination of crops This factor not only complicates the calculation of the extent of plantings but also may lessen the impact of supply response to high prices.

As the growing season progresses, the focus of forecasting switches from area planted to yield expectations. Again, official forecasts are often made by the major producers, but owing to weather variability and the incidence of unexpected pests or disease there is inevitably a degree of error in any forecast. The hope is that many of these factors will, in a large producing country, balance each other, but, because production is often fairly heavily concentrated in just a few most favourable areas, this hope is not always realized (as witnessed in the Russian Federation and the United States of America in 2010). Weather can nowadays be fairly accurately recorded down to small producing areas, but translating current and accumulated rainfall, soil moisture levels, hours of sunshine at critical junctures in the growth of plants, temperatures, snow cover for winter grains, correlation between the weather and pest and disease build up as well as wind and flood damage and human decisions to hoe, to fertilize and to apply pesticides is a very complex matter and, probably, not an efficient way to forecast yields. For tree crops there are additional factors influencing yield; like the on-off yield cycles or prolonged effects of El Niño (and La Nina) weather patterns on palms for 12 months or more. The development of computer modelling will eventually help, but for the present, it is probably better to sample the opinions of farmers as to the state of their crops. This, again, can be done by government agencies, producer associations and private traders, and their opinions can be sought or bought in the same way as forecasts of area planted.

Hiring local experts is a useful approach towards yield monitoring, provided they can frequently visit the main areas at risk of yield variation. Combing local newspapers and monitoring local radio can also yield helpful warnings. In undertaking detailed local monitoring it is essential to have a good baseline of county/region level area, yield and production so that local pieces of information can be translated into effects on eventual production. Baseline data and a survey of local media sources should be undertaken as a one-off piece of research to improve monitoring.

Knowing the level of stocks

If production forecasts are the key element in supply/demand forecasts, stocks are the next most sensitive element. Data on end-of-season stocks, the point during the year when they are at their lowest level, are what is required. Figures at any other time represent supply on hand, not carryovers. For example, at the end of the calendar year, inventories of cereals are near their maximum in the northern hemisphere, indeed they are just a few months into the season, after being harvested between August and November. To make a sensible assessment of exportable supplies for the year ahead, it is necessary to take the crop year or the marketing year as the base. Not all food products share the problem of seasonal production peaks. For these commodities the calendar year can be a suitable marketing year. Total stocks are usually taken to be those in the hands of farmers, food industries and the government. Household stocks are usually excluded.

Aggregation over countries presents some technical difficulties, as crop seasons vary. However, over the years, the international agencies making estimates have developed ways of aggregating that are not problematic. For some countries, they aggregate all their food grains on the same marketing year even though the individual crops are on different bases (e.g. India). The important point for international assessments is that these data can be re-aggregated on a more internationally comparable basis. The basic problem with data on carryovers of grains and oilseeds is that they are often not reported and, frequently, not collected. This applies widely to developing countries but to others too. It is difficult to have complete confidence in world carryover figures in this state of affairs. Countries that do not report need to be reminded of the importance of these data in making world food market and also food security assessments. Estimates are being made and will continue to be made by analysts in FAO, International Grain Council (IGC), USDA and so on. These estimates usually have to make at least rough calculations for an initial year, probably when consumption is at a low and it can be fairly assumed that stocks too had been run down to a minimum level. From this point, annual series of net changes in stocks (production + imports-exports-consumption) can be added and subtracted to arrive at stock level estimates for all later years. Care must be taken so that the sum of cumulative net changes in stocks does not become negative at any point, as was the case with estimates of China's stocks made by international agencies in the 1990s, which prompted a re-examination of the underlying data series of flows.[7]

It is helpful, of course, if other sporadic stock estimates, partial or full, are available for particular years in order to refine the series. These estimates should be discussed with the countries concerned and with international experts called to special study group meetings on these questions. Private traders may also be approached to elicit alternative viewpoints on what is arguably the most difficult part of world food market monitoring.

[7] For more information see FAO (2004).

Some doubts over consumption forecasts

Consumption has traditionally been considered the supply/demand element that was the most stable over time; after all, stock changes and trade flows are essentially there to offset the effect of production variations on consumption. Yet, significant (and often little reported) changes do occur in consumption or consumption policies (including policies related to biofuels). In fact, at the beginning of world food crisis in the 1970s, it was the decision made by the former USSR to maintain consumption levels that caused the unexpected surge in grain imports. By stretching the export capacity of the United States of America, it was such imports that helped set off the grain price rise in 1972. Consumption trends and policies probably are one of the factors that need monitoring, as their impact can have some startling effects, especially when there are a number of closely competing commodities, as in the feed-grains/oilcakes complex (or in the vegetable oil complex) where substitution among products plays an important role. A little-regarded trade concession by the then European Economic Community (EEC) let in a flood of cassava imports to its feed market, pushing out correspondingly large volumes of feed-grains in just a few years in the early 1970s. More recently, the high petroleum price combined with government policies to foster biofuels (in the United States of America and to some extent in the European Union and, increasingly, also other countries) led to a huge diversion of grain and various oil-crops away from traditional outlets and into making fuel. Another little-researched area is the widespread use of vegetable oils as *oleo-chemicals* (other than for biofuel) where technical progress, changing consumer habits, product substitution and other factors cause the market to be very dynamic.

Monitoring of consumption, it is suggested, could focus on the following four areas. First, there is a need to undertake demand studies for the fast growing major developing country markets, as the sheer speed of economic growth means that consumption patterns may move fairly quickly away from consuming basic grains to diets that are richer in protein and other highly income elastic products. Demand studies may also be needed in the oilseeds sector on changing consumer preferences on the presence of Genetically Modified Organisms (GMOs), products produced using environmentally and socially sustainable practices (palm oil) and product health attributes (e.g. saturated fats and trans fats). These studies can be one-off studies to identify the trends to watch out for.

Secondly, data need to be collected more intensively on the non-food uses of grains and oilseeds: not only on feed use but, importantly, also on the various sectors that use vegetable oils for non-edible and non-feed purposes. Data are simply not available for some of the oilseed end-uses in the chemical industry. Changes in the mix of ingredients both in the animal feed sector and the chemical industry can lead to important changes in demand for the raw materials.

Monitoring the end-use industries with a view toward identifying possible changes in input demand would involve undertaking visits to these industries, subscribing to trade journals and discussing with traders. Possibly, technical reports would need to be commissioned to identify changes.

Thirdly, there has been a strong growth in the use of some cereals and oil-crops for making biofuels, so that currently this use accounts for some 12 percent of world production of coarse grains and close to 10 percent of global vegetable oil production. The surge in the production of maize-based ethanol was prompted by policy measures, especially renewable biofuel blending mandates in transportation fuel, as well as higher petroleum prices. The potential for large changes in that end-use is clearly considerable; the whole industry could shrink rapidly if the policies/fuel prices were to change. This sector will need to be closely monitored and up-coming legislation followed for clues as to how this demand could evolve. Fourthly, an underappreciated problem in the utilization side of the supply/demand balances is to be found in the unreliability of seeds and waste estimates. The share of a crop used for seed or, more importantly, crop share wasted can be alarmingly high. The Post Harvest Losses Information System shows, for instance, that losses of cereals in East and Southern Africa amounted to 14-17 percent in recent years. The fear is that high figures would also be found in other countries but that information is sparse. There is, therefore, an urgent need for fresh studies for the countries and commodities concerned.

Trade policy changes

World trade in basic food has expanded substantially (i.e. for cereals by over 40 percent between 1990 and 2010), exceeding the growth of world production and consumption (which for cereals expanded by 24 percent and 30 percent respectively over the past two decades) but it continues to vary over time, mainly because of production shocks and changes in consumption. The volume of trade is also influenced by changes in trade policies – witness the decision taken by a number of countries both in 2008 and 2010 to ban exports, which had notable impacts on market sentiment in those years.

Over the past two decades trade policies have increasingly been geared toward market opening by importers and restraint on export subsidies by exporters. Despite the major efforts made in trade liberalization in the period leading up to (as well as in consequence of) the Uruguay Round, by and large, the change in trade policies has been controlled and market opening usually gradual, at least as far as the major trading countries are concerned. For many of the smaller developing country importers, market opening was often more dramatic and food imports surged.

Although this opening helped in increasing trade, it did not cause upsets in the world market. The main causes of disturbances to world food markets in recent years have been production shocks that affect import demand or export supply, which are then reflected in trade policy adjustments. For example, there was a sharp fall in output in the Russian Federation in 2010 that preceded the export ban; the production drop would have caused, in any case, some fall in exports so the net effect of the policy change is less than the headline effect. Still, trade policy, because it acts directly on the world market, often has a psychological effect on markets that needs to be kept in mind. On the other hand, sharp changes in tariffs or export taxes can and do have real and substantial market effects, as can non-tariff barriers and changes in industry standards (e.g. sustainable certified palm oil, labelling for trans fat content). Thus trade policies need to be monitored, including ongoing negotiations under regional and international agreements

Monitoring price developments

Key to any food market monitoring systems is, of course, prices. But it is necessary to be clear about the type of prices involved. The most immediate concern is the current price paid by food industries and eventually consumers and received by traders and farmers. This current price can be measured by wholesale, retail, producer, import or export prices. Essentially all countries have such data, although not necessarily of the same quality in terms of coverage, frequency and representativeness. Looking for indications of prices in a few months or a year ahead there are futures markets in a number of countries where quotations are available for prices at specific dates and for specific qualities (the Chicago Mercantile Exchange in the United States of America, Euronext LIFFE, as well as those in Argentina, Brazil, China, India, Japan and Malaysia, among others). Price reports, however, are not to be found everywhere; in practice there are relatively few that are open to traders from other countries and which serve as benchmarks for world trade.

Monitoring prices, be they current or futures, is more complicated than meets the eye. There are many varieties and grades of all grains; for rice there are prices for paddy, un-milled rice, polished rice, parboiled rice, graded by percentage of broken rice, long, medium and round grains, aromatic or glutinous varieties, and so on. As far as international prices are concerned, the analyst has to select the most representative and either report these types or prepare price indices, as is now widely done. Using primarily export or import price quotes from specific ports deemed to be representative for world markets, FAO has world price indices for food, rice, oilseeds, oils and oilcakes, dairy and meat products, which are published on monthly basis.[8] Other agencies also construct food/agricultural-related price indices[9] not only because of the heterogeneity of most products but also because prices are often not quoted at certain times of the year or, in particular, when supplies are short. But, in this area, it appears that price monitoring, as currently undertaken, is adequate. The same cannot be said for national domestic price series, where in spite of recent efforts by FAO, improved coverage could be important, especially in the major trading countries.[10] However, because price data are not always of the desired quality, some special efforts may be necessary to improve the flow by engaging local consultants and strengthening local capacity.

Futures prices are structured to refer to a particular date ahead; the length of time ahead that a particular contract refers to gradually shrinks with every day that passes until the contract period closes. The standard view is that the futures price converges on the spot price even though, for technical reasons, the two prices are not equal (the basis). If the classical view is correct, the futures contract typically has to be priced somewhat below the price that the market is expecting (so called normal backwardation), so that the investor in futures contracts can make a gain for the risk being taken. For these two reasons the relation between the futures price and spot prices in the future is not one-to-one. The situation is more complicated when there are next to no stocks in the market in the period when the futures contract is open. In these circumstances, the link between current spot prices and futures prices breaks down and arbitrage[11] over time is ruled out. In other words, while futures prices are a useful pointer to the prices in a few months time, they have to be used carefully.

In recent years, concerns have grown about the influx of investment in the big internationally-orientated futures exchanges by non-commercial interests like banks and hedge funds. The importance of this phenomenon can be gauged by comparing two situations, one without non-commercial interests and another when new buyers for futures enter the market. In the first case, the sellers in the market are basically farmers and the buyers are basically food and feed industries (ignoring foreign trade). Farmers sell forward their future output at a price that they can accept and the industry receives a price at which

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8 Reported regularly on: http://www.fao.org/worldfoodsituation/FoodPricesIndex/en/

9 Such as the S&P GSCI Agriculture Index or Thomson Reuters/Jefferies CRB Global Agriculture Equity Index.

10 Nearly 1 000 price series in 77 countries are produced by FAO-GIEWS and made available at: http://www.fao.org/giews/pricetool/.

11 Arbitrage is the practice of buying or selling when a price difference between two markets is greater than the cost of undertaking the trade (e.g. transport or storage costs).

they can do business. Both "lock-in" the price. The stockists undertake time arbitrage so that the difference between spot and futures price is close to the cost of storage plus a "normal" profit margin. When there is an influx of investment from outside the sector, the demand for futures contracts rises and, through time, arbitrage may raise the spot price. With all the caveats mentioned above, it is clear that an influx of money from outside the commercial sector will raise both spot and futures prices; should such investments leave the market both spot and futures prices will fall. This statistic – the net long position of non-commercial operators – is a useful indicator of market sentiment and should be monitored. Some information and analysis in this regard is included in FAO's Food Outlook reports twice a year along with regular assessment of food import bills and implied volatility, but more frequent and detailed analysis are required in order to enhance transparency and market information.[12] Moreover, other indicators should be developed and a special study should be commissioned to develop such indicators.

Conclusions and the way forward

Improved monitoring must be disseminated if it is to play its role in enhancing market transparency. There is a need for both timeliness and frequency of the outputs. The case can be made that the FAO should issue regular short updating documents to Food Outlook, as it did in earlier years. Regular publication of the supply/demand situation in tabular form, perhaps accompanying price updates and selected number of market indicators, may also be helpful. The important guide for an FAO publication is that the outputs are seen as dependable and independent of special interests. To be timely, however, some risks must be taken and judgements on complex unfolding situations may occasionally err. There is no way of completely avoiding errors or wrong judgments, but an annual, short review of forecasts analysing the performance should also be made available to readers. In addition, we suggest that the monitoring reports of policy developments indicated above be released not only because they are useful on their own, but because they can help other analysts understand the basis of FAO forecasts.

One question that has been left aside is the commodity coverage of the enhanced monitoring. Cereals and oilseeds, oils and oilcakes are discussed above, but it would be desirable to extend this monitoring to include the complex but important group of livestock products in view of their significance to world food trade and food security everywhere. Markets for these products are large and have received a boost from trade liberalization. Livestock products are, however, complicated because they are so heterogeneous, even more so than oilseeds, oils and oilcakes. Price data are often poor and, hence, the use of indices is virtually obligatory. In addition, there is the difference between systems of intensive livestock feeding and feeding on pasture. Monitoring pasture conditions is a weak point in this area and further work is needed.[13]

12 See the Market Indicator section in Food Outlook reports at: http://www.fao.org/giews/english/fo/index.htm

13 At the moment, the monitoring of world food markets organizationally in the FAO is undertaken in the Trade and Markets Division (EST) by a group of food market analysts who work on world markets and prices. The group collaborates closely with the GIEWS, which monitors the situation in all countries from a food security angle. Together, these two groups maintain current season food balance sheets for all countries. Collaboration is close with the Statistics Division (ESS), which maintains the historical database for agriculture on a calendar year basis. The market analysts draw on a myriad of private and public sources and contacts to obtain the information needed for their analyses; they sometimes also draw on technical advice regarding agricultural issues (pests, agricultural inputs, land and water questions) from the FAO's Agriculture Department. They also rely on information flows from the Regional Offices and country representatives.

This review of methods to enhance the monitoring of the world food outlook suggests the following recommended approaches:

1. Improve the forecasts of countries that are the main market movers rather than attempting to improve forecasts for all countries simultaneously.
2. Rely mainly on tapping the expertise of private traders, farmers, national officials and media sources rather than relying on model building, except for attempts to improve forecasts of area planted, which may prove useful.
3. Place emphasis on analysing policy changes and technical developments, as these give an early warning of supply/demand changes at a later date.
4. Increase the frequency and timeliness of publications while keeping them short.
5. Develop and monitor market indicators, including the net long position of non-commercial operators in futures markets.
6. Arrange for regular exchange of forecasts with the private trade as well as with other international agencies and other experts.

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Chapter 23

Addressing the biofuels problem: food security options for agricultural feedstocks[1]

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The recent history of grain markets is not the result of carefully planned public policy for agriculture, energy or the environment. Rather, it reflects the direct and indirect outcomes of errors of premature commitment to incompletely verified science-based initiatives for environmental protection and control of climate change, combined with lack of long-run commitment to necessary conservation. In science and environmental protection policy, the United States of America has continually failed to exploit opportunities to substantially reduce dependence on foreign oil supplies and to push for global collaboration on reduction of greenhouse gases, and the economics profession has offered confused analytical responses. These failures created an opportunity for United States of America farmers to co-opt supporters of green and secure energy supplies and establish a new higher level of grain price support, beyond the dreams of farm bill negotiators and currently unconstrained by World Trade Organization (WTO) disciplines.

First-generation biofuels increase the average cost of food consumption on the global market. Although many in the development community complained for decades that low global grain prices hurt the poor, the main negative effects were borne by farmers who produced, or could have produced, a significant surplus above subsistence. But the most desperately poor are not such commercial farmers; they are typically landless, and higher food prices have the greatest proportional negative effect on them, because they spend the highest share of income on food. Expansion of biofuels that is unpredicted, or so rapid that it outpaces the ability of the economy to accommodate it, increases the threat of further price spikes in response to an incompletely predictable demand shift. Such spikes undermine the well-being, and even the lives of those poor grain consumers in developing countries, whether exporters or importers, who are exposed to world grain price fluctuations, and threatens to destabilize their governments. This chapter explores how bio-fuels derived from staple foodstuffs, or from plants that compete with resources used to produce foods, pose a serious threat to the food security of the world's poor, and proposes measures that allow the diversion of agricultural feedstocks from biofuel production into the food chain in times of acute need.

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1 This chapter is based on Wright (2010).

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Background

The production of biofuels has increased dramatically over the last decade, mainly in response to generous government mandates and subsidies, supported by import tariffs on cheaper supplies that would otherwise be available from overseas. The decision by United States of America authorities in 2007 to double the annual maize-based ethanol mandate from 7.5 to 15 billion gallons by 2015 set maize demand on a predictable, sharply upward trajectory over the following three years. This caused a squeeze on maize supplies available for feed and food. Substitution of wheat for maize in feed, and rice for maize and wheat as food, sent the globally available stocks of calories from the three major grains sharply down towards minimal levels necessary for efficient supply chain operation.

Without the cushion of discretionary stocks, the market for grain calories was especially vulnerable to what would otherwise have been modest global market disturbances. In 2008, the unprecedented extension of an Australian drought and other disturbances induced a spike in price of major grains in 2008, severely exacerbated by panic of importer and exporter governments intimidated by the outcries of their politically powerful urban consumers. Key exporter governments banned or taxed their exports. Their withdrawal from the global market place raised prices further, and increased domestic consumer pressure on other exporters to do likewise. Importers reduced tariffs, increased subsidies or relaxed quotas on grain imports, boosting demand and reinforcing international price jumps. In the international market for the major grains, there was a scramble by importer governments to move all the grain still available to the global marketplace behind their own borders. The panic level rose as suppliers of grain available for import became increasingly scarce. Prices paid by poor countries for their imported grain supplies surged, playing havoc with budgets of nations committed to insulating their consumers from price variation, or directly reducing the welfare of consumers forced to pay more, or cut back on consumption.

In mid-2008, real grain prices fell rather abruptly, but remained above pre-2007 levels, rather than following the downward trends established over most of the twentieth century, as reflected in the FAO Food Price Index. In mid-2010, drought and fires in Russia's wheat growing regions and a subsequent Russian announcement of an export ban, sent wheat prices gyrating. In early October, a United States Department of Agriculture (USDA) maize stocks report sent maize prices down one week, but a week later an unexpectedly low harvest report caused jumps in the prices of maize, wheat and soybeans. The market now expects sustained upward pressure on grain prices in the global marketplace. Prices will also be highly vulnerable to price jumps induced by unexpected demand or supply shocks, despite one of the highest aggregate grain harvests yet achieved.

Maize ethanol, and to a lesser extent biodiesel, is set on a path that is reducing the net economic contribution of the agricultural sector to the United States of America economy, destabilizing global food markets and threatening the security of all food consumers exposed to global markets. We have come so far down this path without a course correction for two main reasons. First, environmental economists and environmental scientists have been too slow to appreciate the weakness of the argument that maize bioethanol efficiently reduces global warming. For too long, economists focused on the direct effect on greenhouse gas emissions of substituting biofuel for petroleum as a essential transportation input in reducing greenhouse gases, while ignoring the indirect effects on emissions through changes on intensive margins, including increased chemical and water use and on the extensive margin through land use changes. It took a lawyer, Tim Searchinger (Searchinger & Heimlich, 2008), to draw attention to our profession of the perils of an excessively narrow conception of market responses in the presence of market externalities.[3]

Second, economists have as a group been confused and confusing about the effect of bioethanol on grain prices. As in the first case, the failure was largely conceptual, a failure to comprehend the full range of relevant market interactions. For example, one study does not include biofuel demand among three possible causes of recent declines in grain stocks.

Similarly, economists have failed to reach a consensus on the effects of biofuels on food and feed markets. This is due in part to the relatively underdeveloped state of the economics of the behaviour of markets for storable commodities. Until very recently, reports of failure of empirical applications of the most promising type of storage arbitrage model, pioneered by Gustafson (1958), have hardly encouraged researchers to pay more attention to this issue. In a series of papers by Deaton & Laroque (1992), Deaton & Laroque (1995) and Deaton & Laroque (1996) made a persuasive empirical case for the proposition that storage arbitrage is incapable of explaining correlation in prices.[4] Empirical models used for policy analysis do not include tested and validated econometric models of storage behaviour because none has been available. In the absence of a well-accepted, empirically supported theoretical model, well-respected economists have identified a variety of drivers of recent price spikes, from low interest rates[5] to fertilizer prices to demand surges in China and India.[6] Several argued that the spikes are induced by financial inflows into commodity markets[7], without explaining how those financial flows could have reduced consumption and increased stocks, a necessary condition for the argument to hold.[8] In fact, aggregate stocks of calories in the major grains, wheat, maize and rice, available to the global market, were at minimal levels, consistent with the storage model, as observed in previous price spikes.

Economic critiques of unidentified domestic "hoarders" failed to observe that in reality the hoarding was being carried out by China (Mainland), India, Argentina and other potential exporters who had removed their stocks from the world market for domestic political reasons, and by frightened importing governments that had been able to grab a large share of available supplies, and put it behind their own borders. Within the global market, consumers with sufficient cash made runs on supplies of rice in retail stores to ensure their own shelves were stocked (Timmer, 2008).

Indeed, storage has often been neglected by economists. Some have even questioned the role of biofuels as a key element of price spikes on the grounds that the price spikes are not necessarily coincident with the largest market shocks, an argument that implicitly assumes

3 Some have argued that indirect land use effects can be ignored. In an undistorted market, such induced effects are reflected in the prices of inputs and outputs. However, the whole point of the exercise is that the indirect effects on welfare via greenhouse gas emissions are not priced, so the costs of conversion of land at the margin understate the true social costs, generating deadweight losses that are not the usual small "Harberger triangles" but larger rectangles.

4 See Chapter 15 as well as Cafiero et al. (forthcoming) for reconsiderations of the methodology and conclusions of Deaton and Laroque.

5 See Frankel, J. 2008. "Commodity Prices, Again: Are Speculators to Blame?" <http://content.ksg.harvard.edu/blog/jefffrankelsweblog/2008/07/25/commodity-prices-again-are-speculators-to-blame> and Calvo, G. 2008. "Exploding Commodity Prices, Lax Monetary policy and Sovereign Wealth Funds." <http//www.voxeu.org/index.php?q=node/ 1244>.

6 See Chapter 3 and Wright (2011) for a discussion.

7 See Chapter 14 for a discussion.

8 In an interesting exchange with Krugman, Calvo has argued that a bubble can occur without a change in stocks if demand is vertical. But Calvo's argument implies that food price spikes do not reduce consumption. Were that the case, effects of price spikes on the grain consumption of the poor would not be an issue.

grains are non-storable.[9] When a commodity is storable, the same shock in supply or demand can have very different effects on price depending on the availability of stocks.[10]

Farm interests in the United States of America, not similarly confused, have been able to exploit the window of opportunity afforded by analytical confusion of economists and environmentalists to unite their financial and political influence in favour of policy commitments to increased biofuels consumption. They intelligently support studies that defended those commitments, and have endeavoured with demonstrable success to suppress consideration of negative environmental effects, such as those associated with indirect land use, in government intervention in support of biofuels. They are currently striving to divert blame for high grain prices to petroleum producers, implying that high farm costs are causing grain price spikes. Recent large land price rises are one among many pieces of evidence that this argument is implausible. Yet it has support in some recent economic studies (see for example Baffes & Haniotis, 2010).

The dual challenges of biofuels

The expansion of biofuels has had two distinguishable effects. The first is to raise the level of prices by sustained diversion of supplies from food and feed consumption, much like the sustained decline in grain harvests that is feared by scholars of global warming. This happens directly via competition between food and feed users and biofuel users for the same grain, but also indirectly, via substitution of one grain, such as maize diverted to biofuel feedstock from use as food or feed rations, leading to substitution of a food grain, such as wheat, into animal feed. In turn, rice is substituted for wheat in human diets (as happens at the margins in India and Mainland China). Indirect competition also occurs via bids for land for the planting of crops for food, feed and biofuels, including possible future non-food crops such as miscanthus or switchgrass.

The second effect is to make market prices more volatile. In the short- to medium-run, this can happen owing to changes in mandates or subsidies, or changes in trade interventions, that are incompletely anticipated and difficult to accommodate. In the longer run, it will continue to reflect shifts and shocks in energy markets, which have hitherto been transmitted via input costs, which tend to have less abrupt effects, operating as they do via anticipated supply rather than current output, a link which is weakest when prices are spiking and storage is negligible.

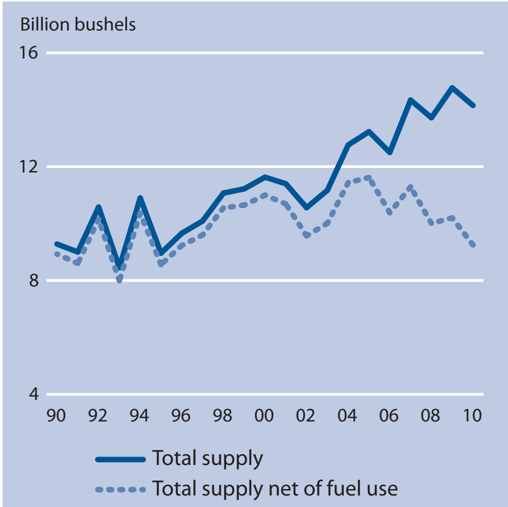
A sustained demand increase owing to large expansion of biofuels mandates and associated biofuels policies is so great that it cannot realistically be accommodated nearly as fast as smaller, less persistent shocks. Yield increases have in the long-term been impressive, but they cannot be expected to continue at more than a few percent per year. The gap caused by biofuels demand is much larger, even after accounting for the feed value of by-products such as distillers' grains (see Figure 23.1).

Diversion to biofuels can be reduced by improvements in biofuel production and processing efficiency. It is possible that current efforts to achieve efficient cellulosic biofuel production will succeed in a decade or two, boosting yields per acre and/or yield of biofuels per ton of harvest. Given great success, land demands to fulfill given mandates could decline, reducing pressure on food supplies and lowering food prices. But if biofuels are shown to be more efficient than expected, two quite different, less happy scenarios might ensue. In

9 See for example Baffes & Haniotis (2010).

10 See Cafiero et al. (2010) for an illustration using an empirical model of the sugar market.

Figure 23.1: US maize supply net of fuel use



Source: USDA, Feed Grain Database, data accessed on 5 February 2011.
Note: Total supply = beginning stocks + production; total supply net fuel use = total supply - fuel use.

one, mandates might be expanded in response to arguments by special interests that they are cheaper than expected, and substitution of food for liquid energy could expand, keeping prices high. Second, biofuels might become competitive with petroleum on a regular basis. In either case, pressure on food prices will increase, not decrease. It is hard to see a good end, from the point of view of food consumers over at least the next decade, to the long-run story of commitment to biofuels.

Maize ethanol and biodiesel have turned out to be ill-advised economic, social and environmental policy. The best policy response now, for those who care about the fate of the world's most vulnerable consumers, would be to reverse commitments to market interventions that favour these biofuels. However, we cannot ignore the possibility, even the likelihood, that current commitments to grain and oilseed biofuels will be maintained and even expanded in countries currently producing them, despite the misgivings of economists and policy analysts. Furthermore, recent reports raise the prospect of the spread of food-based biofuels to South Africa, Uganda, Kenya, the Republic of Mozambique and other developing countries. Prudence dictates that we consider in advance policies that merit consideration that could mitigate the effects of biofuels on shorter term price volatility.

Policies to mitigate effects of biofuels on vulnerable consumers

Flexible mandates

De Gorter & Just (2010), among others, have suggested that mandates be conditioned on prices of food, so that the mandates can be reduced or eliminated if food prices rise beyond some trigger point. This proposal would introduce some flexibility into a rather inflexible policy. However, reduction of the mandate will not ensure that poor consumers have some protection from competition with energy use of their basic foods when petroleum prices are high enough to support biofuels production in excess of mandated levels.

Variable subsidies

Tyner (2008) has suggested that if the blending wall were shifted so that it does not bind policy in the United States of America, a variable subsidy on ethanol would be superior to the current fixed subsidy of USD 0.45 per gallon, because it would reduce the incentive for biofuels production when none is needed. Beyond this, however, it provides no protection of poor food consumers who must compete with biofuels producers for food when petroleum prices are high. When prices are low, public funds are being spent to keep biofuel plants running, a very inefficient way to ensure that capacity is maintained when production is uneconomical.

Box 23.1: The WTO and biofuels

WTO subsidy disciplines do not prohibit all subsidies or support to biofuels. Rather, the WTO rules concern themselves with subsidies that have a trade-distorting effect. Although often cited in discussions about the WTO and biofuel subsidies, the green box provisions of the WTO Agreement on Agriculture (AoA) do not provide a broad category sheltering measures on the basis that they offer some environmental benefits.

To qualify as green box support, specific requirements must be met. For example, payments under environmental programmes must be limited to the costs of compliance with the programme. The issue of whether subsidies have been passed on to the benefit of other participants in the biofuel production chain may be particularly relevant in a biofuels context, where subsidies are provided at various stages of the production and use chain.

Attempts to provide assistance by way of decoupled payments are likely to be scrutinized closely, and the requirement that a payment not be related to production will be applied strictly. Importantly, if there is some condition attached to the payment that would have an impact on production – positive or negative – then it is not likely to qualify as a decoupled payment. Many countries have sought to foster domestic production and use of biofuels, raising the prospect of policies that favour domestically sourced biofuels. For this reason, biofuel polices that express a preference for domestic over foreign sourced biofuels raise may present problems as prohibited on local content subsidies. In addition, this review has identified some complex issues that arise from the interaction between trade rules and biofuel subsidies that warrant further examination. These include:

- how ethanol subsidies should be notified under the WTO, in particular the scope of ethanol subsidies that should be properly included in a WTO Member's Agricultural Market Support (AMS) calculation. Given that ethanol is an agricultural product, it is conceivable that some subsidies to ethanol producers are provided in favour of the producer of the basic agricultural feedstock and thus should be included in the AMS;
- the multiplicity of biofuel subsidies and other incentives, which can lead to situations where the interaction between two measures has a trade-distorting impact. In such a case, the question arises as to whether the combination of the measures could be an actionable subsidy, where taken individually neither measure would meet the threshold requirements;
- how these biofuels and their feedstocks, such as switchgrass, would be classified for WTO purposes, given the shifting focus of support in many countries to second- and third-generation biofuels.

Source: Harmer (2009).

New WTO disciplines

A recurrent proposal is to have ethanol and biodiesel reclassified by the WTO as fuels rather than agricultural feedstuffs, exposing the sector to more competiveness. As agricultural products they are enmeshed in the tradition of wide-scale subsidization that has hindered world trade and stands as a principal obstacle to resolving the Doha round of world trade talks. Concerning subsidies, WTO member countries can file a case, if a subsidy provides an unfair advantage to another country. But if subsidies and other support measures are classified as part of an official mandated policy, for example environmental programmes, there is no case to answer by another country.

It is clear that both the above mitigation measures have merit, but equally obvious that they will not prevent the poor from suffering when biofuels demand soar. In the next section I propose that option contracts can be useful in attacking this problem directly.

Options to divert grains from biofuel and feed uses in emergencies

Biofuels production is significant in the United States of America, the European Union, Brazil and Argentina and is spreading to other countries in Latin America, as well as to some sub-Saharan African countries. The prospects of oil prices above USD 100 a barrel mean that even in the absence of mandates and subsidies, biofuels production may increase. If the pressure of energy demands on food supplies continues to increase, there will be a serious threat to the food security of the world's poor. I believe, therefore, that serious consideration needs to be given to the establishment of option contracts as "safety valves"– measures that allow the diversion of agricultural feedstocks from biofuel production into the food chain in times of acute need.

Option contracts to protect the poor

These options are of greatest relevance in those countries pursuing or contemplating ambitious biofuels programmes that have large populations vulnerable to food shortages. They may also be important for developing countries with export-oriented animal feeding industries to facilitate the diversion of animal feed supplies to food uses in emergencies. It should be possible, for example, to use options contracts to ensure diversion of some feed grains and oilseeds from use as biofuel feedstocks to domestic use as food distributed to vulnerable consumers during food price spikes, without undue hardship to the generally more prosperous consumers of substantial quantities of energy or meat.

This substitution might be direct, or indirect via substitution of biofuels feedstock for grains fed to animals, and diversion of that grain to human consumption. Governments wishing to protect the food consumption of the most vulnerable could purchase call options on grain from biofuel producers, with appropriate performance guarantees. This could be done by a sealed-bid auction, for example. Diversion could be triggered by specified indicators of food shortages, and the biofuels supplier would commit to making a corresponding reduction in output (rather than substitute other food grain as feedstock).

Delivery specifications could be designed to help ensure the grain will get to where it is expected to be needed in a market emergency. Various combinations of contingent contracts could be used to achieve the same end. As participation would be entirely voluntary, they are no threat to biofuel producers, who by revealed preference gain when they participate. Such contracts offer the additional advantage that they reduce the hazard, often non-negligible, that biofuels producers could have their stocks confiscated by the government or by a mob in a food crisis, especially if government stability and public security are compromised. These arrangements, like domestic storage, facilitate fast response to domestic food emergencies, and offer freedom from uncertainty about foreign transport availability, timeliness or cost.

Governments might well find diversion option contracts cheaper in the long-run than storage of an equivalent amount of emergency supplies. If acute food supply emergencies are infrequent, the annual cost of the option should be low, relative to the expected cost, including interest on the capital invested in grain, of holding a given level of stocks off the market until the emergency occurs.

For a programme to protect the poor, the grain diversion trigger could, in principle, be related to a measure of the needs of the target population or the declaration of a regional food disaster. If necessary to assure that programme decisions are less subject to manipulation owing to pressure from interested parties, the trigger could be the local grain price. However, the programme is not designed to stabilize the price, but rather to assure the needs of the poor and vulnerable consumers. It is interesting to note that should future research successes mean that production of biofuels becomes dominated by cellulosic feedstocks, such as *miscanthus* or switchgrass, this potential flexibility provided through options could be lost. These second generation feedstocks cannot be economically diverted to food or feed uses to mitigate acute shortages. Reallocation of acreage to produce more food or feed would take too long to be useful in an acute food shortage. In the case of miscanthus, for example, planting is expensive as it involves rhizomes, not seeds, and establishment takes years, so a switch to such perennials is a relatively inflexible commitment.

In developing economies, the objective of the programme should be to protect the food supplies of the most vulnerable; effects on food prices would be a secondary consideration. The establishment of similar safety valve type measures might also be sensible in developed countries pursuing ambitious biofuels policies, in order to safeguard access to agricultural feedstocks for emergency food aid purposes. A larger programme might also serve to lessen pressure on global prices in tight markets, in particular if the country in question is a significant producer and exporter of a particular commodity, as is the case for United States maize production.

Biofuel feedstock diversion in the United States of America?

The United States of America is both the world's largest producer and exporter of maize. It is worth noting that United States maize exports, sizeable as they are, only account for ca. 15 percent of total demand for United States maize. Indeed, one hundred and twenty-five million tons of grain is now used annually for ethanol in the United States of America (Runge & Johnson, 2010). The mandated surge in ethanol consumption in the United States of America has now reached the size where it roughly matches the blending requirements in the United States of America. Ethanol supplies have hit the "blending wall" at which the renewable fuels standards are satisfied. Within two weeks of this conference, the United States Environmental Protection Agency decided to expand the ethanol-blending limit from 10 to 15 percent of gasoline consumption.

As pointed out by the USDA, "this means that prices are largely determined by supply and demand relationships in the market and the rest of the world must adjust to prevailing prices"

The argument for further expanding ethanol or biofuel consumption today is even weaker than the argument behind the 2007 decision. Prior to 2007, the encouragement of ethanol blending as a preferable alternative to the carcinogen Methyl Tert-Butyl Ether

(MTBE) as a pollution-mitigating fuel additive had arguably positive environmental and health effects.

A long-run feature of public policy in the United States of America has been the failure to charge car and truck drivers, and other consumers, the full marginal cost of their energy usage. Drivers do not pay the marginal cost of fuel consumption in terms of decreased safety and increased congestion, let alone the cost of energy dependence, pollution and global warming. Early gains in fuel economy after the oil shocks of the 1970s were not extended in later decades, as the market mix drifted in favour of larger, heavier, more profitable but not necessarily safer vehicles, whose size and configuration made drivers of smaller cars less secure, reinforcing the market drift. The shorter-run policy failure was the mistaken choice of MTBE as a fuel oxygenator designed to reduce atmospheric pollution. When it became widely recognized that the additive was carcinogenic, and reports indicated a threat to drinking water safety, regulators resorted to ethanol as an available and more environmentally friendly substitute. Thus, the United States of America biofuel industry is an accidental outcome of a failure to pursue energy conservation opportunities, a mistaken choice of additive to reduce atmospheric pollution, and an overly optimistic view of the prospects for second-generation biofuels.

Though the large 2007 expansion transformed bioethanol into a serious competitor for grain calories, and introduced energy market fluctuations into the grain market, the case can be made that these consequences were unforeseen by many economists and politicians far beyond the inner circle of the Bush Administration. Nor could the slowness of cellulosic ethanol to emerge as a significant source of biofuels have been perfectly anticipated by scientists or economists. The same case cannot be advanced as convincingly now, in defense of support of expanded bioethanol or biodiesel consumption.

However, biofuels expansion naturally pleases farmers at least in the short-run before land rents completely adjust, because it will raise prices and incomes. It especially favours landlords, agricultural or urban, because it boosts land prices in anticipation of higher future revenue flaws. The powerful constituency behind aggressive biofuels policy includes both groups, along with processors who want to keep their plants working at capacity, suppliers of agricultural inputs, such as fertilizers, machinery, seeds and pesticides and owners of agricultural land. This constituency has the money to support studies claiming that ethanol has no important effect on food availability or prices, and the influence to persuade politicians that mandates should be expanded. This constituency also has staying power as newly wealthy landholders realize their gains, and buyers who pay the expected present value of future gains will have to defend current policy just to prevent capital losses. The possibility that demand for food and feed for biofuels will increase as planned, or even be further boosted by expansion of biofuel mandates faster than currently planned, must be taken seriously in formulation of policy.

The United States decision on facilitating expansion of biofuels commitments by moving the "blending wall" has occurred at a critical juncture for the United States of America and the OECD. Public commitments made now will affect grain markets and grain consumers for years to come. Unfortunately, it is difficult to be optimistic that prudent decisions – decisions that protect public budgets, enhance national efficiency and competitiveness and protect poor food consumers worldwide – will be chosen.

Among those experienced observers of biofuels policy who are not financially committed to either side of the issue, there is an emerging consensus that grain ethanol and biodiesel based oilseeds have turned out to be unwise policy initiatives, scientifically, economically, socially and environmentally, both domestically and internationally. It is important to present economic analyses that lead to that conclusion as clearly as possible, in the face of highly motivated efforts by special interests to divert attention.

In the current political climate in the United States of America, it appears unlikely that the current rising path of biofuel demand will be abandoned, and highly likely that it will be revised upwards. An options approach for ensuring diversion of agricultural feedstocks away from energy towards food uses could be a useful element of policy in the United States of America. Unlike variable mandates, options contracts would protect consumers not only from shocks to food supplies or changes in biofuels mandates or subsidies, but also from shocks that increase petroleum prices, which have been newly linked to food market demands via the advent of biofuels.

Are these options feasible?

The idea that fixed supply commitments might be improved by options to withdraw supply in specific circumstances is by now familiar in interruptible electricity supply contracts, typically offered by an electric power distributor to industrial users, with a lower supply cost as the incentive. These are imperfect analogies to what is proposed here, because the interruptions are generally brief, minutes or hours, rather than months or years. However, other more similar options, to increase security of water flow to hydropower generators using interruptible irrigation contracts, were discussed decades ago by Hamilton et al. (1989) and McCarl & Parandvash (1988).

Similar options, to secure security of urban water supplies, were evaluated by Michelsen & Young (1993). [11] Farmers or their water districts in effect agree to accept the possibility of interruption of irrigation water by diversion to urban use via "dry year options." Such options have been implemented to protect hydro electricity supplies and urban water supplies in the face of the prospect of a water shortage. For example, in the past decade, dry-year call options were negotiated between the Metropolitan Water District of Southern California (MWD) and Sacramento Valley irrigators at an option price of USD 10 per acre-foot. In 2003 the MWD exercised options at an exercise price of USD 90 per acre foot for transfer to urban consumers of almost 100 000 acre feet of water (Colby & Pittenger, 2006). Irrigators switched to less water intensive crop production to facilitate the transfer.

It is clear that such options can work to protect consumers' access to essential water supplies, protection of endangered species and other urgent or legally mandated requirements. The analogy to food security options to protect the essential food supplies of consumers is clear. As with dry-year water options, success will depend on careful attention to the details of contract design. In particular, the design of the exercise price or other trigger needs careful consideration, and plans to ensure that the food released goes to the most vulnerable, for example via "food for work" programmes, require careful *ex ante* investment of attention and funds.

Conclusion

It is becoming increasingly obvious that use of grain and oilseed for biofuels is of dubious benefit to the environment, uneconomical and a threat to global food security. The best policy would be to reverse the direction of policy and eliminate these ill-considered initiatives. Unfortunately, the policies have created constituencies with the power and financial strength

[11] Some technical issues are addressed in Hansen et al. (2008).

to exercise great influence over policy decisions. If, as is likely, these policies are maintained and even expanded, then their worst effects might be mitigated by food security option agreements similar to those I outline above.

These options are not a universal solution to the food security challenge and the exact nature of such contracts and their implementation would need to be tailored to the needs of specific markets. If designed carefully and implemented before a new, possibly much more serious, grain price spike occurs, such contracts could facilitate a diversion of commodities away from energy use to maintain the consumption of vulnerable populations during times of scarcity. They might also help to reduce pressure on global prices when undertaken by wealthier countries with significant food or feed-based biofuels industries and thus mitigate price hikes. Although the exact impact is debated, experts agree that an ongoing rapid expansion of biofuels from food and feed crops will increase the average cost of food consumption on the global market. In today's climate of high commodity prices, we must bear in mind that the most desperately poor are not the commercial farmers, who might indeed benefit from the effect of biofuels on the prices of what they produce. Those with most to lose are typically landless, and higher food prices have the greatest proportional negative effect on them, because they spend the highest share of income on food. Expansion of biofuels that is unpredicted, or so rapid that it outpaces the ability of the economy to accommodate it, reduces carryover stocks of grains and oilseeds, raises food price levels and increases the threat of further price spikes in response to any unforeseen short-run disturbance. Prudent humanitarian food policy would seek to mitigate the effects of such spikes to the wellbeing of poor grain consumers in affected developing countries, whether exporters or importers. Diversion option contracts for grains used as biofuels feedstocks could be part of such a policy.

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Chapter 24

Targeting the most vulnerable: implementing social safety nets

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The populations most vulnerable to food price shocks must be protected immediately from the resulting loss of purchasing power. Such protection not only saves lives, it can also strengthen livelihoods and may promote longer-term development. Safety nets can prevent and reduce the risk of malnutrition in human capital that has lifelong, irreversible consequences. More secure livelihoods prevent distress sales of assets, allow investments in education and health and keep households from falling into the poverty trap.

The term "safety net" is an umbrella for various types of programmes aimed at assisting vulnerable population groups. They include food distribution programmes, cash transfer schemes, various feeding programmes and employment schemes. Many countries have one or more safety net programmes which in turn have varying degrees of coverage. However, not all countries have safety net programmes in place because of budgetary costs and administrative complexity.

While the idea of a safety net in the context of high food prices may be conceptually straightforward, the formulation, design and implementation of such a programme is complex. Many possibilities exist and no specific programme design is inherently better. Its design should depend on local objectives and conditions; many safety nets combine elements of the options outlined above. Most importantly, a programme's design should be driven by the needs and circumstances of a particular country or region and its beneficiaries, rather than by the needs and priorities of donor countries and agencies.

This chapter draws upon experiences of safety net programmes in the context of rising and volatile food prices, and provides operational guidelines for their implementation. In particular, I discuss various modalities for targeting, setting appropriate benefit levels and financing safety net programmes, as well as ways to evaluate policies.

Motivation

While households that are net sellers of food may benefit from price increases, the large majority of the poor are *net buyers* of food, and are negatively affected by spikes in price.[2]

[1] Agricultural Development Economics Division, (FAO).

[2] Typically, a 1 percent increase in food prices in low-income countries leads to a 0.75 percent decrease in food spending (Regmi, 2001).

Among the worst affected are the urban poor who survive on fixed incomes and the landless and labour-constrained households living in rural areas.

In periods of high prices, there is a need to forestall further poverty increase, to protect livelihoods and to ease social pressures by helping households maintain their access to food, health and education services. Several policy instruments are available for this purpose. They can be categorized into two main groups. The first set of policies includes those that are *not targeted* and operate at the macro level. In the context of internationally rising commodity prices, one option is to increase domestic food supply by liberalizing food imports and/or restricting food exports. Another possibility is to insulate domestic food prices from fluctuations in the world market by intervening in domestic food markets (Revenga & Wodon, 2008).[3]

As discussed in Part 2 of this book, many of these policies have, however, attracted substantial criticism because of their potentially controversial macroeconomic consequences. While import liberalization is consistent with mainstream policies, restrictions on exports as well as price interventions are usually not considered "market-smart" and may, so the argument goes, distort producers' and consumers' response to rising prices, introduce inflationary pressures and hurt food commodity importers (Wodon et al., 2008). Because none of these policies exclusively target their intended beneficiaries, they may channel resources to the non-poor, who do not need such assistance.

The second group of policy instruments includes those that exclusively *target* resources to the poor and vulnerable. Safety net programmes are non-contributory transfers targeted to the poor aiming to protect them from falling into destitution while also assisting the more permanently poor in gaining self-sufficiency (Grosh et al., 2008).[4] The most important safety net policies include cash transfers, in-kind transfers (school feeding, supplementary feeding, take home rations), public works programmes, fee waivers (for healthcare, schooling or transport) and food stamps. These are discussed in Box 24.1.

In the context of rising commodity prices, however, only certain safety net programmes are considered effective. Grosh et al. (2008) provide a loose ranking. They consider targeted cash transfers to be the "best option", followed by various types of in-kind transfers. At the bottom of their list are public works programmes, which "rarely achieve coverage sufficient to be the whole response to rising food prices", and general food price subsidies, which are "regressive, distortive, costly, and hard to eliminate".[5]

Following the above ranking of safety net policies, our focus will be on cash and in-kind transfers. Both compensate households for increasing food prices and are considered to be the "best types" of intervention.

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3 Food imports can be liberalized by reducing import tariffs and taxes and relaxing restrictions on import. Exports can be restricted by raising export taxes and introducing restrictions or even bans on export. Intervention in domestic food markets includes introducing general consumer subsidies, price controls and using food grain stocks to increase domestic supply.

4 In addition to trade and social protection policies, other recommendations for dealing with price increases have included revoking bio fuel subsidies, boosting agricultural growth through investments in agricultural research, extension, rural infrastructure and market institutions and taking global actions to calm markets by making futures trading more costly (von Braun, 2008). Addressing these policies is beyond the scope of this chapter.

5 As the core of the problem is declining purchasing power, and not employment *per se*, scaling up public work programmes - which might introduce potential distortions in the allocation of labour supply - appears to be less favourable (Lustig, 2009).

Box 24.1: A catalogue of safety net programmes

Cash transfers include the distribution of cash or cash vouchers. They can be unconditional or conditional, and require the beneficiary's participation in health, education or public works programmes. Cash transfers are appropriate where food markets work and where the objective of the intervention is improved ability to purchase food. Unrestricted cash transfers allow households to make decisions as to how to spend the cash, whether on food, essential non-food items or on investment needs. Such interventions can also foster local market development in food and other goods by providing greater incentives for the private sector to engage in higher-volume, more stable marketing channels. However, where food prices increasing rapidly, the value of transfers will need to be adjusted in order to maintain purchasing power. This can complicate fiscal planning.

Other approaches to improving access to food, such as food stamps, are also appropriate where local food markets work and where the root cause of hunger is the lack of access to food. Food stamps can foster local market development, primarily of food products, and have the advantage of being more politically acceptable. They may also be more difficult to divert to "undesirable" consumption and may be self-targeting (wealthier households are less interested in vouchers or food stamps than cash). In addition, food stamps have lower transaction costs than direct provision of food aid. However, they have higher transaction costs than cash transfers and may restrict the household's ability to choose the most appropriate expenditures. Moreover, the selling of food stamps in the shadow economy may undermine programme goals.

Food-supply based programmes provide food or nutritional supplements directly to individuals or households. They are most appropriate in low-functioning food markets where cash transfers or other forms of income support would be less effective. For example, providing cash or food vouchers in areas where food is not readily available could disrupt local markets and drive up prices. Such conditions typically require direct food aid or "food for work" programmes, which constitute the primary safety net implemented by the World Food Programme. Other types of direct food distribution programmes are warranted in cases where specific members of the household are particularly vulnerable to food insecurity or malnutrition. In these cases, school lunches or food supplementation may be necessary.

Direct food-based assistance is fundamentally different from cash or food stamps; it is most appropriate when an insufficient supply of food is the root cause of hunger. Such programmes are often more acceptable politically, perhaps because it is difficult to divert the aid to undesirable consumption. Importantly, food aid is often donated to the receiving country, with the quantity of food aid available often reduced when world prices rise. However, the fact that food aid is often granted free of charge may cause governments to ignore more appropriate and sustainable solutions.

Source: FAO (2008).

Targeting

The first step in designing a social safety net is to decide *who* should benefit from the programme. This entails answering two questions:

- which population group will the programme target? and
- what method of targeting is the most appropriate for this purpose?

The objective of the social safety net is to protect the livelihoods of those population groups who have been negatively affected by an adverse shock such as high food prices. There is consensus in the literature and among development practitioners that the most affected population group is the poor who are net food buyers and spend a high proportion of their income on food. There are several arguments that justify targeting the poor. First, with low levels of per capita income, the poor suffer the most when high prices negatively impact their budget. Second, the marginal value of a transfer is higher for the poorest. Thus, targeting the poor will mean a greater impact on social indicators.

Several methods can be used and combined to target resources to the poor. Below I review targeting methods that aim to channel resources to identified population groups and hence exclude those not in need from the programme. I suggest that methodological based targeting is preferable to universal transfers, in spite of the likely targeting errors, which will also be discussed.[6]

Methods of targeting

The various targeting methods can be grouped into three categories:

- The first group includes methods that *assess the eligibility* of the individual or the household in need of assistance. Eligibility can be determined by status of wealth (measured by means and/or proxy means tests) or assessed by the community (community based targeting).
- Second, beneficiaries can be selected based on *categories* such as age (demographic targeting) or place of residence (geographical targeting).
- Finally, it is possible to design a programme in such a way that it encourages the needy to *target themselves* while discouraging (but not excluding) the participation of those are who in less need (self-targeting).

When put into practice, programmes tend to combine the various targeting methods; typically, using one type does not exclude using the others.

Assessing eligibility

Means testing investigates an individual or household's income level. The information collected is usually verified against independent sources and tested to see if it falls below a certain level. Though, by definition, means testing works best in settings where declared income is verifiable, collecting income information, especially in developing countries, is a notoriously difficult exercise as economic transactions are rarely documented. Implementing means tests, therefore, requires the highest capacity and incurs high administrative costs. Such an investment should be justified by high benefit levels and balanced by achieving the most accurate targeting.

Proxy means testing is an alternative way to establish the wealth status of an individual or a household. Various sources of information can be collected and combined into a single index to allow ranking of poverty or vulnerability. Such variables may include: the quality of the dwelling, ownership of different assets, demographic structure, occupation and the level of education of household members.[7] While collecting such information may be easier than trying to accurately assess income, proxy means testing may not be the most accurate indicator of shifting poverty levels. As characteristics of chronic poverty, these features tend to be stable and slow to change, and are thus less sensitive to rapid changes in welfare or

6 Targeting remains a controversial and hotly debated topic. Those in favour optimistically assess targeting experiences and argue that the poor can benefit to a greater extent from scarce resources if they are channelled exclusively to them. Universal transfers, they find, are impossible owing to budget insufficiencies. At the other end of the spectrum, those who favour universal transfers highlight recent unsatisfactory targeting experiences, arguing that the bulk of resources leak to the non-poor and there is little, if any, hope that targeting performance will improve in the future. The author of this paper prefers the view that targeting can produce optimum results if well implemented.

7 On the complexities of estimating real per capita expenditure/income and the advantages of "asset scores" in poverty analysis see Sender & Smith (1990, p. 29). The definition and measurement of "poverty" is subjective and the measure of welfare should correspond with the programme's eligibility criteria.

income. Even though means and proxy means tests demand high administrative costs, they are usually justified by more accurate targeting.

In community based targeting, members of the community are responsible for selecting the programme beneficiaries. Depending on the programme's objectives, members of the selection committee may be school officials, members of a parent-teacher association or village elders. Because it uses local information, this method is less costly than the others. But relying on rather ambiguous local-specific definitions of vulnerability can also make evaluations challenging, especially when programmes across districts are compared.

Categorical targeting methods

It is best to use geographic targeting if poverty and vulnerability are spatially concentrated and living standards across regions vary significantly. Using only geographic targeting limits eligibility to those living in designated areas and assures that both poor and non-poor benefit to the same extent. While using this method rules out stigmatization, it increases certain political risks because some areas may receive special preference. For these reasons, many safety net programmes combine geographical targeting (maps of poverty, vulnerability or food security) with other methods.

Demographic targeting uses age or gender to target beneficiaries. It rests on the assumption that people are particularly vulnerable in certain periods of their life such as in childhood and old age (even though age is not necessarily highly correlated with wealth). The advantage of targeting based on age, apart from being relatively simple to administer and cheap to implement, includes its universality and hence political popularity. The errors of excluding targeted beneficiaries are also potentially low.

Self-targeting

Self-targeting assumes that participation in the programme will be higher among the poor than the non-poor. Eligibility criteria are established in such a way that, although technically open to anyone, the poor will find greater incentives to participate. There are at least two common applications of self-targeting. The first is when public programmes set wages so low that better-off individuals/households have no incentive to participate. The second frequently cited example is when less preferred (inferior) food commodities (those normally consumed only by the poor) are subsidized (see Chapter 25). The advantages of self targeting include low costs of administration and low errors of inclusion.[8]

Errors and costs of targeting

Targeting is never completely accurate and will always lead to mistakes and leakages to non-eligible individuals and households. Two errors are often cited in regard to targeting efficiency:

- Errors of *exclusion* (Type I error or F-mistake): when poor individuals/households are identified as non-poor and therefore cannot access the programme.
- Errors of *inclusion* (Type II error or E-mistake): when non-poor individual/households are identified as poor and are admitted into the programme.[9]

8 In the case of public works programmes, errors of exclusion can be significant if the programme cannot satisfy a pattern of demand for labour and the number of poor households willing to participate exceeds the number the programme can employ. Vulnerable households are often labour-constrained and do not have the means to participate.

9 The two errors are usually expressed in percentages (of benefits reaching the poor) and can be calculated

There are various costs involved in targeting, all of which are incurred at different levels. The implementing agency is responsible for *administrative costs*, such as collecting information about potential beneficiaries. It is often difficult to isolate these expenses because staffing is usually shared among several programmes or within divisions of a single programme. In practice, administrative costs are usually relatively low. In a review of eight major social safety net programmes implemented in various countries Grosh et al. (2008) find that targeting costs range from 25 to 75 percent of administrative costs (and on average around 4 percent of total administrative costs).

The *private costs* of targeting are "paid" by the beneficiaries. They include the time and monetary spent on application, travel, registration, participation and compliance with programme conditions. By definition, these costs reduce the net benefit of the transfer to the recipient.[10]

Targeting also involves *political costs*. Political processes may impact budgeting decisions. Voters may support safety net programme because they value social justice and political stability and consider it their obligation to support the poor. Alternatively, they may have direct interest in a specific programme, such teachers' unions supporting school feeding programmes.

Finally, a programme's *social costs* may include stigmatization, the feeling of shame associated with being a beneficiary. This can potentially discourage the eligible and most needy from participating in safety net programmes.[11]

Safety net targeting guidelines?

Targeting method

Most targeting methods can be used and combined in cash and food transfer programmes. The same modalities apply for responses to rising food prices. For example, it is possible to target cash and food transfers to the poor by means and proxy means tests, categorizing methods (geographic or demographic characteristics), community-based targeting or self-selection as well as nutritional status or risk factors. Evidence shows, however, that the success of targeting depends less on the choice of the right targeting method than on how the targeting process *is managed*. According to a World Bank study (Wodon et al., 2008) only 20 percent of targeting performance variation can be explained by method, the remaining 80 percent is determined by targeting *management*.

When implementing targeting, the following general rules should be followed:

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with the following formula: $Error\,of\,inclusion = NP^{covered}/NP$; $Error\,of\,exclusion = P^{notcovered}/P$, Where P stands for the number of poor (eligible) and NP for the number of non-poor (non-eligible). An example of low inclusion errors includes Argentina's Trabajar Workfare programme, which was able to transfer 80 percent of benefits to the poorest quintile of the population, that is four times the share they would have received through random allocation. At the same time, the programme had high exclusion errors; it covered only 7.5 percent of the unemployed. The successes of targeting vary around the world. There have been several failures where targeting is regressive and random allocation would have provide greater share of benefits to the poor (Coady et al., 2008).

10 Participants may be required to change their behaviour to comply with certain programme conditions. Such costs are referred to as incentive (or indirect) costs. A positive example is when a school feeding programme encourages households to send their children to school. A negative example is when some households may decide to work less in order to fall below the minimum income threshold that qualifies them for the programme.

11 It is often difficult to determine the actual costs of targeting. For example, registration procedures and database management are undoubtedly part of targeting costs, but they are also part of universal programmes. While it is easier to quantify and measure administrative and private costs, social and political costs are rather polemical and it is challenging to attach a monetary value to them.

Combine targeting methods instead of relying on one method. Using a number of methods usually yields better targeting. For example it is possible to target the poor (identified through means tests) in a particular area (geographical targeting) and aim benefits to the elderly and most vulnerable (demographic targeting). Each method has advantages and disadvantages (as reviewed earlier), and the best method will depend on the circumstances and the characteristics of the specific programme. Combining methods may also be preferable if a safety system has to be set up urgently as a response to a food price spike.

Define eligibility clearly and unambiguously. Targeting errors, especially inclusion errors, can be significantly reduced if the poor are distinguished from the non-poor and eligibility is classified according to clear and publicly announced criteria. For example, social protection programmes in Nepal define "elderly" as those aged 75 and over, which it is relatively high compared with most definitions used in other countries. However, this definition succeeds in narrowing down the group of people eligible candidates. A less exact targeting criterion has been used in Zambia where the "poorest 10 percent" have been targeted in recipient villages. But seeing as more than 30 percent of Zambia's population is chronically poor, this method leaves some ambiguity in targeting (Grosh et al., 2008).

Budget, costs and benefits

The programme's budget, its total cost and level of recipient benefits are all interlinked. In order to increase the effectiveness of targeting, the following recommendations apply.

Ensure the availability of sufficient funding. The greatest errors of exclusion are often caused by a lack of funding, which imposes a limit on the number of participants. Sufficient resources should be allocated for inputs (including material and information systems), monitoring and evaluation, and sufficient policy attention. Administrative budgets should be dedicated to facilitating outreach efforts.

Adjust the level of private cost. The private costs of the programme should not be too high or too low. If set too high, the poor will not be able to participate and exclusion errors will increase. If too low, the non-poor will participate and drive up inclusion errors. Because private costs are rarely quantified, qualitative judgement is often the best way to receive feedback about the programme.

Minimize social cost. Reduce stigmatization by launching publicity campaigns to encourage participation in universal programmes (for pregnant women or children under five) and to discourage the non-poor from applying. The beneficiary roster can either be kept confidential or made public, depending on the type of programme. It is advisable to keep this information private if those who are excluded from the programme are not in a position to identify participants.

Adjust the level of benefit. A commonly used method to increase targeting efficiency is to adjust the level of transfer to the size or structure of the recipient household instead of delivering a uniform transfer (see below).

Programme design, implementation and management

Assign sensible roles to participating institutions. Often, several institutions take part in the implementation of safety net programmes. Their collaboration should be harmonized.

Allocate staff to carry out multiple functions. Staff should carry out multiple functions and/or work on more than one programme at the same time. This will reduce administrative costs. Keep in mind, however, that lower investment in the administration of targeting may result in less administrative effort devoted to this task, and may lead to higher leakage of resources and less narrow targeting. Administrative costs should not be cut significantly at the start-up phase. Costs are usually higher at the initiation of a project, and include initial investments in equipment, staffing, etc.

Make the programme dynamic. Allow the entry of new beneficiaries as well as the exit of participants who are no longer eligible. Rising food prices affect different population groups differently and some of the poor become poorer while some of the non-poor fall into poverty. Open eligibility procedures allow applications to be made at any time. Keep the system flexible and make expansion administratively simple.

Allow sufficient time for development. Systems develop over time. A well-designed targeting system that is constantly improving can become the basis of a coherent social policy. It may only take several months to set up a reasonably well-functioning targeting system Bear in mind that too rapid set-up can result in targeting can errors and may undermine the prospects of a sound long-run social policy. If the proper length of time is not available, it may be justifiable to use other methods in the short-run and the prospects of designing a more accurate household targeting system will increase.

The case of Armenia shows how social assistance programmes can be efficiently reformed to streamline targeting. In 1991, the country inherited a generous cash benefit system along with heavily subsidized goods and services. The social assistance system consisted of several small and uncoordinated cash programmes that the government decided to consolidate and implement through a tightly run administration. This resulted in several changes. First, the programme targeted low-income households instead of relying on the more ambiguous categories of "poor" and "non-poor"; second, the programme used proxy-means tests to determine eligibility (instead of means tests), thus taking into account a large share of the informal economy; third, the government scaled down the subsidy on electricity. The reforms yielded great results, as the share of benefits targeting the poorest 20 percent increased from 16 percent to 32 percent in one year (Grosh et al., 2008).

Setting the level of benefit

One of the basic problems in designing a safety net programme is determining how much people should be paid. While there is no clear-cut answer, a general recommendation is to set the benefit level so that it maximizes outcomes to the beneficiaries while fitting within the programme's administrative, budgetary and political constraints. A benefit set too high will cause fiscal burden and may generate dependency, reduce work incentives and crowd out private transfers. If, on the other hand, the benefit is too low, the programme will lack impact and fail to achieve its objectives, while incurring high administrative costs relative to the size of the transfer.

The coverage of safety net programmes needs to be expanded in order to offset the negative impacts of increasing food prices, which include declining income, increased expenditure on and reduced consumption of food. The purpose is to raise beneficiaries back to the same level of wealth (and consumption) at which they were before the prices hike.

If the country has ongoing programmes and functioning operating systems in place, there are at least three strategies for expansion:

- First, it is possible to keep the same beneficiaries and increase the level of benefits transferred to them. This is perhaps the easiest and least demanding solution.
- Second, the size of the programme's coverage can be extended by admitting more beneficiaries. Increasing the threshold for a means or proxy means test is one such example.
- Third, the targeted area can be expanded to other regions of the country in order to include more beneficiaries. This is slightly more complicated, but can yield impressive results.

Many countries have small and under-funded safety net systems. Often, coverage is insufficient not only for those who recently fell into poverty, but also for those who needed assistance even before the increase in food prices. These people will fall into deeper poverty and therefore more significant investment is needed to cover demand for additional resources.

The level of benefit can be estimated in various ways.[12]

Estimate benefit based on income. As argued earlier, safety net programmes designed in response to increasing food prices should target the poor, who are best identified through their income level. Safety net programmes often target the poorest 5-20 percent of the population, and although the size of transfer may differ, they usually cover on average 20 percent of household income.[13]

Estimate benefit based on adequate food basket. If the programme's aim is to compensate the poor for their declining food consumption, the benefit can be estimated according to the level of an "adequate food basket", also called the food poverty line.[14] An increase in food prices will push the food poverty line upwards, mirroring the adequate level of compensation needed to offset the negative impact of the price increase. Each household below the original food poverty line, as well as those new households who have just fallen below the new line, should be compensated to the extent of the additional cost of the food basket. For example, the Jamaican Food Stamp Programme authorizes the purchase of rice, cornmeal, skim milk and wheat flour, all of which constitute a basic local food basket (Grosh et al., 2008).

Box 24.2: Estimating safety net benefits

Suppose that the poverty line represents 80 percent of per capita Gross Domestic Product (GDP). 15 percent of the population is poor (at income levels below the poverty line) and the average food consumption of the poor is 25 percent below the poverty line. In this case the overall cost of the programme will be 3 percent of the GDP:

$$80\% \times 15\% \times 25\% = 3\%$$

If, as a consequence of increasing food prices, the food poverty line rises by ten percentage points (to 90 percent of per capita GDP), an additional 5 percent of the population will be pushed below the poverty line ($15\% \pm 5\% = 20\%$). The poor's average food consumption would still fall at 25 percent below the poverty line, and the overall cost of the programme would be 4.5 percent of the GDP:

$$90\% \times 20\% \times 25\% = 4.5\%$$

The difference - 1.5 percent of the GDP - is the cost of compensating the poor for the increase in food prices. Clearly, this calculation excludes targeting errors (leakage) as well as other (mainly administrative) costs of targeting and implementation.

12 There are several ways to determine benefit value. The most straightforward is to report the value in local currency, or, if the purpose of the exercise is to compare countries, purchasing power parity is a useful common denominator. Alternatively, different ratios can be calculated that compare the benefit of the programme with other indicators. For example, it is possible to report the benefit level as a share of wage, a share of the poverty line or a share of the total consumption of beneficiary households.

13 Another option is to set the benefit level as a fraction of the income gap, i.e. the ratio between the income or consumption of an average household and the eligibility threshold (the poverty line). This method is used in guaranteed minimum income schemes. In the case of public works programmes the benefit level (wage rate) should be set somewhat below the legal minimum wage, i.e. the wage level for unskilled workers.

14 The local food basket contains the minimum quantity of commodities that an average individual (or household) should consume in order to lead a healthy life. The composition of the basket (mix and proportion of each of the commodities it contains) can be derived from consumption surveys which are also used in food balance sheets to estimate a country's food requirements. By attaching monetary values to each of the commodities, it is possible to estimate the cost increase of the food basket. In cases where data are available it may be possible to tailor the food basket to the consumption of the poor who might consume a different mix of commodities, but in developing countries such data may not be available.

Estimate benefit based on opportunity cost. A safety net programme may have secondary objectives. For example, it may provide incentives for households to accumulate human capital by boosting school enrolment or encouraging the usage of health services. In this case, the benefits should compensate households for the opportunity cost of the time children spend in school (and not working), or the time household members spend attending health centres. In Honduras, for example, opportunity costs were included when the level of education grant was determined. In addition to the various direct costs (fees, matriculation, books, uniforms, lunch, transportation, etc.) the income contribution of children per household was estimated (survey data showed that children provide about 3 percent of labour hours and 2 percent of average household income), converted to USD, and added to the direct costs of schooling (Grosh et al., 2008).

Use variable benefit formula. Benefits can be differentiated according to characteristics such as size and composition of the household, age and gender of members (taking into consideration the young and the elderly) or the household's specific needs or behaviours. The level of benefits can also vary in time and by region: it makes sense to increase benefits during the hunger season or to adjust their level according to the cost of living in certain areas. For example, Brazil's *Bolsa Familia Programme* provides two types of benefits: a base benefit for all families in extreme poverty and a variable benefit depending on family composition and income. The variable benefit is set according to the number of children in the family and/or whether the mother is lactating or pregnant (Grosh et al., 2008).[15]

Adjust benefit levels to inflation. The increase in food prices tends to be higher than total inflation, which implies that there is a difference between the share of benefits as a proportion of household income and the share of benefits as a proportion of expenditure on food. If beneficiaries are to be able to purchase the same amount of food that they previously did, then the programme's benefit level should be raised above that of inflation.

The overall cost of the programme, which aims to compensate the poor for the increase in food prices, will depend on its benefit level and coverage. When making decisions about each of these factors, it will be necessary to take budgetary constraints into account, as most safety net programmes have limited funding.

Financing safety net programmes

There are basically four funding sources for safety net programmes.[16] It is possible to rearrange expenditures, increase taxes, or finance programmes through either international grants or borrowing. Each of these options has its advantages and disadvantages, and the most suitable option depends on the situation of the particular country.

Expenditures are reallocated when governments replace general subsidies with targeted safety net programmes and/or when funds are taken away from other programmes to fund new projects. While reallocation does not require new resources, the disadvantages include limited funding and political resistance to reducing funding in other activities. There are several examples where expenditure has been reallocated successfully. Savings from the elimination of general food subsidies were used to fund a Food Stamp Programme in Jamaica in the mid-1980s, and petroleum subsidies were converted into spending on health, education and cash transfers in Indonesia in 2005 (Grosh et al., 2008). If social safety nets are funded from

[15] Several options were considered when the programme's benefit level was being determined. The first was to deliver higher benefits to families with older children in order to reflect the opportunity cost of their staying in school. Others argued that benefits should be differentiated by gender. It was also suggested that regional disparities should determine the size of the transfer.

[16] The majority of developing countries spend around 1-2 percent of their GDP on safety nets, although these data should be treated with caution. Not all countries are involved in the calculations, figures across countries are not always comparable (it is not always clear what should be included as a "safety net programme"), and the interpretation of figures also varies across countries.

additional taxes, attention should be paid to political costs. Many believe that government revenues are the best way to finance safety nets.[17] A general rule for this type of funding is that the amount taken by taxes should not be higher than what is given back to beneficiaries.

Grant financing is a popular way to fund safety net programmes, although it has opportunity costs.[18] Financing safety nets through grants poses several problems. First of all, funding is often guaranteed for a limited amount of time, often only one or two years. Aid flows tend to be committed to relatively short periods and owing to inflexibility they can only cover a proportion of programme costs, but not the whole. A further constraint is that it may be difficult to realize economies of scale if several donors fund similar projects, but do so separately, following their own conditions. Finally, borrowing and debt financing can only be justified if the programme benefits future generations, builds capacity to generate income, raises productivity and future tax revenues - all of which will enable the country to repay the debt in the future. Examples of this include education or infrastructure. It is usually justified to borrow in times of a crisis when expenditures increase temporarily.

The following recommendations can be made on financing safety nets:

Finance safety nets in a countercyclical manner. Funding for safety nets should increase during economic downturns and in times of need, both because the number of poor rises and because they require higher benefits. There are, however, several problems with countercyclical funding: during crises government revenues fall and they are forced to reduce expenditures. One option is to set up a special fund and use these contributions during recessions. It is possible to set up grain reserves and release them on the market when food insecurity increases. Spending on safety nets usually increases during economic downturn, even though few safety net programmes are fully funded in good times. Examples of which include Mexico, India and the Philippines, which keep reserve funds for relief programmes, or India, where a specific tax is used to fund countercyclical public works (Grosh et al., 2008).

Ensure that funding comes from the national level. There are several reasons that safety nets should be funded at the national level. It will ensure that people of similar circumstances are treated equally in terms of benefit levels, criteria of eligibility and delivery of service. National financing will help prevent similar population groups being treated differently in different regions of the country.[19]

Create a mix of incentives between the national and the local government. While safety net programmes are often financed nationally, their implementation is carried out by local institutions that are better acquainted with local customs and have superior knowledge about potential beneficiaries. The local governments' (implementers') actions should correspond with the goals of the policy.

Local governments should be asked to contribute to funding. Requesting local implementers to contribute to financing the programme may help achieve better results in implementation.

Allocate funds to regions in a fair and predictable way. The level of funding from the national to the regional level can be determined based on indices of poverty, size of population or tax capacity in the area.

Timing

The timing of social safety net programmes is another important aspect consisting of several steps from initial design and phase-out. There are at least three phases of a programme where timing is crucial:

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[17] Such tax instruments include income taxes, VAT, sales taxes and payroll taxes.

[18] According to theory, the marginal benefits of additional spending on safety nets should be higher than the marginal costs (i.e. the alternative uses of funds). However, in practice it is difficult to quantify in monetary terms the cost and the benefits of programmes, because they have diverse impacts. Funds can be spent in a host of sectors and in diverse programmes, making it challenging to quantify marginal benefits from the different forms of spending.

[19] Because poorer areas have less revenue but higher incidence of poverty, national financing should also ensure that resources are channelled from the richer to poorer regions.

- first, *when* the programme should start;
- second, *how fast* the system should be developed, and what are the consequences of it being designed too quickly; and,
- third, *how long* should the programme last and when should it be scaled down or sustained over time.

In this section I discuss the timing, frequency and duration of cash and food interventions and their various implications for programme design.

In rural areas, harvest time is a key temporal reference point with several implications for social assistance programme implementation. While the period preceding the harvest is often the "hungry season," the next few months see the main concentration of household income. Seasonality is thus related to the objectives of the safety net programme, and transfers are likely to differ at various times of the year. Cash grants distributed before the harvest are likely to be spent on food and meeting basic needs. The value (purchasing power) of cash will depend on food prices, which tend to be higher before the harvest. The same transfers after the harvest are more likely to be spent on productive investment and restocking and can have long-lasting impact on livelihoods by generating a shift in contractual arrangements between households.

Agricultural production cycles and harvest time also impacts food distribution programmes. Food transfers should provide more resources during the acute phase of the crisis, which normally coincides with the hungry months.[20] The conventional belief is that in-kind transfers are usually slower than cash transfers because of higher transaction costs (such as transporting physical quantities of food). It should be noted that this is not necessarily the case in every situation. Procedures and systems for delivering cash transfers are often not established, bottlenecks in administrative and financial systems may cause frequent delays in payments. Cash transfers may actually take longer to implement than food transfers.[21]

The timing and frequency at which a programme administers payments may also encourage behavioural changes in its beneficiaries. In school assistance programmes, for instance, it has been found that a lump-sum payment upon graduation positively impacts school attendance, while reducing monthly payments and adding an end-of-year bonus did not. Timing and duration of social assistance programmes can further determine transaction costs and influence the consumption-smoothing benefits to the poor. Nevertheless, the timing a programme chooses is also a function of the interplay of interests between local groups and international agencies.

Timing also makes a difference for the design of effective exit strategies. When the safety net programme is over, several options can be followed:

- The first is to transform the programme into a permanent safety net. Programmes that have achieved significant results and generated improvements should be used as a basis for building a sustainable long-term social policy. Maintaining such programmes helps prepare for and manage future covariate shocks.
- The second possibility is to scale back social protection interventions once they have achieved their short-term goals. This is the case if policies were less efficient or if benefits are not sustainable over the long-run. Programmes will be easier to scale down if their temporary nature has been announced at the outset.

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20 In the case of school feeding programmes, timing is essential to maximize impact on educational objectives.

21 For example, banks may take a long time to prepare disbursements and are not always flexible in the timing of their distribution.

- The third option is that programmes scale down "automatically" if households voluntarily withdraw as their needs decline, regular recertification renders them ineligible, or if payments are set in nominal terms and inflation erodes their real value over time.[22]

Finally, timing matters in evaluations and adjustments of the programme. For example, in order to track progress and accurately assess the programme's impact, it is useful to conduct a baseline sample survey of a control group in advance. There is also a time lag between gathering information on the programme's performance and adjusting it to these requirements. Reducing or suspending benefits owing to non-compliance of recipients usually takes several months. The frequency of verifying compliance depends on capacity constraints and on the programme's specific conditions.

Frequency of payments is another important dimension that ultimately depends on the objectives of the individual safety net programme. Quick and regular deliveries of smaller amounts of cash (or food equivalent) will be required if the programme's objective is to transfer basic needs. On the other hand, if the aim is to recover livelihoods over a longer span of time, larger sums of cash are needed mostly in the programme's recovery phase. In practice, cash transfer programmes have used different schemes for payments ranging from monthly and bimonthly to quarterly disbursements. The frequency of payments also has implications for the programme's disincentive effects. In the case of one-time payments or temporary (one year) transfers, disincentive effects such as changes in the labour supply are unlikely to occur, while in the longer run such effects may happen as households have time to adjust.

Based on the above, several recommendations can be made on how to manage the timing of social safety net programmes.

Allow sufficient time for resources to be delivered. Markets may be too disrupted and infrastructure may be damaged for fast delivery of cash. Also, the rapid transfer of resources may imply that responsibility and decision-making power is deployed to the local level and field managers may be granted too much authority to distribute grants without appropriate procedures.

Work towards the development of a sound social protection system. Short-term interventions provide a great opportunity to design, test and implement systems that can become the basis of a long-run social protection system. Such interventions can effectively deter the introduction of general subsidies. In certain cases where temporary programmes do not contribute to permanent policies, discontinuing and closing them down may in fact help such policies emerge. In general, policies with short-run actions should aim towards the development of a sound long-term system.

Distinguish between the objectives of small and large transfers. Programmes that deal with smaller transfer amounts deliver basic needs and should be implemented quickly and regularly. By contrast, if the programme's objective is livelihood recovery, then larger transfer amounts will be required and an extended time-frame for planning and establishing well-functioning targeting systems is necessary.

Evaluation

Evaluating programmes is important for several reasons. Evaluations provide feedback on implementation, highlight changes in outcomes generated by the programme and indicate whether the programme achieved its intended results. Evaluations aim to find ways to improve overall effectiveness, identify successful aspects, indicate areas where changes are needed, and recommend strategies for scaling up, modifying or even stopping

[22] The potential danger with the latter is that administrative costs can become too high proportionately.

the programme. Evaluations are an essential part of a learning process about safety net programmes.[23]

There are various types of evaluation, each of which focuses on different aspects of the programme. The most common are process evaluations, which assess targeting accuracy and impact evaluation. Comprehensive evaluations include all of these types and may have additional components.

- *Process evaluation* investigates the programme's implementation process and it is often used throughout the life of the programme. It indicates whether the programme has been implemented as planned and provides feedback to implementing agencies. While a process evaluation can substitute for an inadequate or poorly performing monitoring system, it does not explain why a particular problem emerged or how it can be solved.
- *Impact evaluation* analyses whether the programme has achieved its goals and intended outcomes, and whether these changes can indeed be attributed to the programme or are the result of some other factors. Impact evaluations use control groups that are similar in all aspects to the treatment group, except that they do no receive benefits. Depending on the programme's objectives, an impact evaluation can assess changes in income, poverty status, food security, consumption, health, school attendance, education, and so forth.
- *Assessing targeting accuracy* looks at what proportion of the beneficiaries is poor and whether targeting errors have been sufficiently low. Target accuracy assessment is an alternative to impact evaluation, although it produces less precise results. For example, it cannot explain the distribution of benefits and pays no attention to the impact of transfers on several other dimensions of welfare.

Guidelines on conducting evaluations

Setting up an evaluation system is a complex exercise involving several steps. The following recommendations should be followed.

Design the system according to the programme's objectives. The structure of each programme includes three dimensions: it processes inputs in order to generate outputs that will have outcomes to beneficiaries. Evaluations can only reveal a programme's effectiveness if its objectives and strategy have been clearly articulated.

Develop a comprehensive plan. The evaluation plan should identify what kind of resources the process will require, the type of information that will be collected, what indicators will be developed for the programme (see below), and how the data will be analysed. The plan should be followed throughout the evaluation exercise.

Collect relevant data from various sources. Information for the evaluation can be collected from various sources using different techniques. They include administrative data (staff, administrative costs, benefits), beneficiary surveys (to investigate the quality of service), surveys of households (whether the programme is targeting the poor), surveys of impact evaluation (comparing programme beneficiaries with a control group who did not receive benefit), and qualitative techniques (key informant interviews and focus group discussions).

Pilot test and refine the system continuously. As the evaluation is implemented, new facts, data and information may arise that should be incorporated into the evaluation exercise. The system should be flexible enough to process such information.

Keep the evaluation unit independent. In order to the be as objective as possible, the unit should be granted sufficient authority and have direct access to higher level authorities such as heads of agencies or ministers.

23 Monitoring is different from, but complements, evaluations. While monitoring is a continuous process, an integral part of a programme which provides regular information and feedback, evaluation is a one-off exercise, an external assessment of effectiveness, which is normally undertaken at the end of the programme. In this chapter, I only deal with evaluations in detail, although the indicators discussed later can be used for monitoring as well.

Table 24.1: Indicators used in monitoring and evaluation

	Input		Output		Outcome
		Efficiency of service delivery		Effectiveness	
Definition	What resources are used to deliver transfers?	How efficiently are inputs used to produce outputs?	Transfers / services delivered and beneficiaries served	How does outcome change per unit of output?	Are the objectives of the programme reached?
Indicators	Budget allocation for transfers; Number of staff; Staff time; Other administrative resources	Amount of benefits processed by staff member; Cost of processing payment per beneficiary; Average cost of programme per beneficiary.	Number of beneficiaries served (total or percentage of target); Amount of transfers paid; Amount of services delivered;	Average benefit achieved per beneficiary.	Improvement in consumption; Decrease in poverty; Increase in wages; Improvement in human capital
Examples		Number of beneficiaries reached per US$1000 of administrative cost.	Average value of cash transferred per household; Total cash transferred; Number of schools benefiting from school feeding; Number of meals distributed; Number of participating health centres; Number of lactating women / children who received a monthly take home ration.	Average increase in consumption (outcome) per amount of resource delivered by the programme (output)	Percentage of families who rose above poverty line; Increase in school enrolment; Decrease in prevalence of malnutrition; Change in asset levels of chronically poor;
Expenditure	Cost effectiveness				Outcome
	Cost benefit analysis				

Facilitate communication and coordination in complex programmes. Programmes may have different implementers, or several levels may be involved in implementation. Their actions should be harmonized.

Report information in an understandable and possibly disaggregated format. Disaggregating indicators according to beneficiary subgroups or characteristics of the service increases accuracy. Always report the targets and objectives of the programme.

Indicators

Various indicators can be used to monitor and evaluate programmes. According to the programme's objectives, there are input, output, and outcome indicators, each of which attends to different aspects of the programme:

- *input* indicators include resources used to deliver transfers;
- *output* indicators focus on cash and in-kind transfers as well as on services delivered to beneficiaries; and,
- *outcome* indicators indicate the extent to which the programme reaches its objectives of improving consumption, raising incomes and wages and facilitating human capital development among participants.

Indicators can describe various subsets of the programme, but they do not in themselves provide information about its efficiency or effectiveness. For this purpose performance or efficiency indicators can be calculated which "stand between" the input, output and outcome indicators. Between the input and output indicators the "efficiency of service delivery" indicator describes how effectively inputs have been used to produce outputs. Between the output and outcome indicators "effectiveness indicators" describe the programme's result, i.e. the relationship between output and outcomes.

Other indicators do not focus on a subset of the programme, like the previous ones, but aim to describe the programme's *overall* effectiveness. They include *cost-effectiveness* analysis and *cost-benefit analysis*. Both of these indicators examine the relationship between the total expenditure and the final outcome of the programme and investigate whether the costs of the programme justify the benefits. Cost-benefit analysis is used when the output of the programme can be expressed in monetary terms, while in cost-effectiveness analysis benefits cannot. Table 24.1 summarizes the various indicators and provides some practical examples for each.

Indicators can be expressed in the form of *levels* (the number of beneficiaries or the cost of the programme), *ratios* (the increase in school enrolment per unit cost) or *percentages* (the proportion of beneficiaries who are satisfied with the programme). Indicators should be valid (focus on the aspect of interest), reliable (different people using the same indicator should arrive at the same conclusion), cost effective (gathering information should be worth the investment), sensitive (pick up changes rapidly) and timely (data should be processed and collected quickly).

Finally, some practical guidance and advice on the usage of indicators:

Calculate most of the above indicators for the majority of programme. Using several indices as opposed to relying on just one will give a wider picture about the function (and impact) of the entire programme.

Track indicators over time. To evaluate progress and the impact of the programme it is useful to monitor indicators over time. Make sure that different agencies track the same indicators and define them the same way.

Report indicators according to their frequency. The frequency of reporting indicators will depend on the type of data (weekly or monthly indicators for school enrolment, or data collected over a longer period in surveys) and on the cost of collecting data.

Set targets for the relevant indicators. Having targets helps evaluate the overall effectiveness of the programme. Targets can be set based on current performance, assumptions, or experience with similar programmes implemented in other countries or contexts.

Conclusion

Those who are most vulnerable to food price shocks need to be protected immediately from their resulting loss of purchasing power. Such protection not only saves lives, it can also strengthen livelihoods and may promote longer-term development. Safety nets can prevent and reduce the risk of malnutrition and human capital that has lifelong, irreversible consequences. More secure livelihoods prevent distress sales of assets, allow investments in education and health, and keep households from falling into the poverty trap.

Among several safety net instruments, the focus of this chapter has been on cash and in-kind transfers. It is seen that the level of benefit should be set where the outcomes for beneficiaries are maximized while the programme's administrative, budgetary and political constraints are observed. The purpose is to return beneficiaries to the level of wealth and consumption at which they were before the prices increased. The ration size can be estimated through various methods. It can be based on household income or determined by the level of an "adequate food basket". The opportunity cost of the programme is another important benchmark to decide whether the safety net programme will be worth the investment.

Poverty targeting through means or proxy means tests can be effectively combined with categorical methods including geographical and demographic targeting. The appropriate method will depend on the objectives and on the circumstances of the programme. Costs and errors can be reduced by allocating staff to carry out multiple functions.

There are basically four sources from which safety nets can be financed. It is possible to rearrange expenditures, increase taxes, or finance the safety net through either international grants or borrowing. Each of these options has its advantages and disadvantages, but the situation of each country will determine the most appropriate option. Safety nets should be financed in a countercyclical manner with funding originating from the national level. The allocation of funds to regions should be made in a fair and predictable way and local authorities' actions should follow the policy guidelines.

Timing, frequency and duration are also important dimensions of safety net policies with implications for programme design. In rural areas harvest time is an important point of reference: "lean" periods precede the harvest and income for the majority of households is concentrated around that time. Seasonality is thus related to the objectives of the safety net programme and the use of transfers is likely to differ at different times of the year. Cash grants distributed before the harvest are likely to be spent on food and on meeting basic needs. The value (purchasing power) of cash will depend on the prices of food, which tend to be higher before the harvest. The same transfers after the harvest are more likely to be spent on productive investment and restocking and can have long-lasting impact on livelihoods.

Evaluations provide feedback on implementation, highlight changes in outcomes generated by the programme and indicate whether the programme has achieved its intended results. The most important indicators of evaluation are input, output and outcome indicators, in addition to two other indicators measuring the efficiency of service delivery and effectiveness of the programme. The more indicators are calculated, the clearer the picture about the effectiveness of various dimensions of the programme.

Implementing social safety net programmes is a complex exercise that creates great challenges for policy-makers. This chapter has provided general guidelines for their implementation, keeping in mind that safety net programmes are context-specific and only general recommendations can be made. Cash and food transfers have been implemented for several decades and substantial experience has been accumulated. Periods of rising food prices, however, locate these programmes within a different perspective and pose additional challenges in targeting, rationing, timing, financing and evaluation of programmes.

Each aspect of cash and food transfer programmes discussed in this chapter has a vast literature, compiled over decades from thousands of programmes implemented in various countries and contexts. When designing social safety net programmes, policy-makers should reflect rationally and rely on individual experience and their own society's circumstances. Hopefully, this chapter will be of some help in this process.

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Chapter 25

Targeting the most vulnerable: implementing emergency reserves and other food security instruments[1]

Agricultural Support Systems Division (FAO)

Introduction[2]

The evident failure by global cereal suppliers to commit to maintaining importers' uninterrupted access to their exportable grain has highlighted the need for commitment-reinforcing mechanisms for vulnerable countries.

As discussed in Chapter 21, futures contracts eliminate counterparty risk with respect to performance, including delivery at the designated location such as Chicago in the United States of America, or South African Futures Exchange (SAFEX) in South Africa. But in remote countries, risks related to counterparties such as financiers, agents, transport monopolies and neighbouring governments with power over transport routes, remain very high and often impossible to hedge. Furthermore, a regional futures market may be shut down or exports banned by the host country.[3] The difficulty of establishing and coordinating global food reserves and maintaining confidence in them when they are needed most pose too great a risk for national food security. This is clearly the case for landlocked African countries, which rely on transport infrastructure of border countries and are subject to foreclosure of crucial land-based trade routes.

Consequently, for some countries, a national food reserve that aims to meet security goals rather than modify price behaviour might be considered an essential element of a prudent national security policy. In practice though, many public storage interventions are targeted at price behaviour rather than consumption goals. The key question, then, is how large the reserve should be. The answer must depend on the facts of each case, including the diversity of food supplies, dependability of traditional suppliers, likely duration of trade disruptions, effects on private storage, and the cost of running the programme per unit of incremental

1 This chapter is largely drawn from FAO (1997).
2 Adapted from Wright (2010).
3 Both actions were taken in India in 2007. Trading on the domestic rice futures market was halted, and an export ban was announced when world grain markets fell far short of emergency conditions. The United States of America set a modern precedent for agricultural export bans when it briefly banned soybean exports in 1973 under the Nixon administration and in 1980, when the Carter administration embargoed grain sales to the USSR.

storage given the substitution of public for private storage.[4] Such stocks tie up capital for the substantial intervals between releases and can be expensive to maintain.[5] In addition, efficient programme management uses scarce human capital, and temptations for corruption can easily arise.

This chapter provides guidelines for implementing and managing food security reserves. Particular attention is drawn to operational modalities that minimize disruption to the orderly working of markets in times of emergencies and in times of quiescence. The chapter also introduces other market non-distortionary instruments that can serve as the front line of defence during food crises.[6]

Definitions

The concept of an emergency or food security reserve can be set against the generally accepted FAO definition of food security: "a situation in which all people at all times have access to adequate quantities of safe and nutritious food to lead a healthy and active life". This definition requires three basic conditions to be met: 1) adequacy, i.e. supplies from domestic production, stocks and imports are sufficient to meet the nation's needs; 2) availability, i.e. stability of supply both spatially and temporally throughout the year; and 3) access, i.e. the population has sufficient purchasing power to gain access to its food needs. Clearly, emergency or food security reserves play an important role in shoring up food security during times of crisis.

The primary function of such reserves is to provide the first line of defence in the event of a food emergency. In most countries there exist groups of people who are in, or are vulnerable to, a state of food insecurity. Excluding the chronically food insecure,[7] the sectors of the population that are vulnerable to periodic food emergencies are those who are transitory food insecure. Those falling into this category (such as urban dwellers) are normally dependent on the market for their supplies. Urban dwellers would normally have the resources to purchase their food needs from the market, but they can be vulnerable to shortfalls in market supplies and/or exceptionally high prices. Another group who comprise the transitory food insecure are those people in rural areas who are normally self-sufficient but, in times of food shortages resulting from poor harvests or damage to their on-farm stocks, do not have the resources necessary for purchasing their additional food needs from the market.

A food security reserve is the first line of defence for coping with food emergencies because it provides a breathing space between identifying the possibility of a localized or wider food shortage and making the necessary arrangements to mitigate its impact,. For the

4 Wright & Williams (1982) used a calibrated dynamic programming model of the United States Strategic Petroleum Reserve to show that, on average, one gallon placed in the Reserve would displace roughly one-half gallon of private domestic stocks. The subsequent history of the reserves generally confirms this prediction.

5 Stocks would be "rolled over" with no net release as frequently as needed to maintain quality.

6 As these fall into the class of safety nets, issues concerning targeting are not discussed here but are treated in the preceding chapter.

7 Chronic food insecurity results from structural problems and as such cannot be overcome by periodic interventions of food from the reserve. Its resolution requires programmes aimed at identifying and conquering the underlying reasons for the population's inability to produce sufficient food crops or other economically tradable outputs (e.g. non-food crops) to meet their needs. In the meantime, these populations must have continuing targeted support programmes that provide them with the means to gain access to basic food needs. Meeting the supplementary food needs of such population groups is not normally considered a function of a food security reserve, but rather the task of specialized relief programmes.

purposes of a food security reserve, a food emergency can be defined as: "when there are clear indications that an acute and widespread food shortage, extensive suffering and dislocation in the life of the community on an exceptional scale are imminent, and that these dangers cannot be overcome by the normal supply procedures".

Because the functions of an emergency reserve are essentially humanitarian, many of its operations are inherently non-commercial and will therefore be financially irrecoverable. The humanitarian and social functions the reserve is expected to perform are decided by governments and should be clearly spelled out at the time of its establishment, along with the circumstances and the manner the reserve should be used if adverse conditions arise. A food security reserve is therefore one of the tools available to governments to support its humanitarian responsibilities and social policies. Thus, in order for the reserve to sustain its activities, the government must be prepared to provide necessary financial support through periodic financial injections.

By presenting various options, these guidelines are intended to serve as a practical guide for those involved with determining the need and an appropriate structure for a food security reserve.

Motivation

Food security reserves emerged in response to the events of the 1970s, when a prolonged drought in sub-Saharan Africa resulted in a series of disastrous harvests throughout the region. The seriousness of the situation was compounded by a simultaneous worldwide cereal shortage that led to prices rising to record levels. Limited availability and high prices meant the donor community could provide only limited food aid, resulting in many people from the region experiencing famine. The effects of these events were also felt in many other countries around the world that, because of scarcity and cost, had difficulty making adequate provisions for necessary imports to supplement their own shortfalls in production.

To reduce the severity of such events in the future, governments in several vulnerable countries, in consultation with the donor community, embarked on the development of both programmes to ensure adequate food availability for affected populations as well as national food security strategies. Emphasis was laid on propositioning basic cereal stocks in vulnerable countries to be ready for use in the event of future food emergencies. These stocks were not intended to cope with the entire emergency, but rather to provide for the basic needs of the affected population during the lead time required for arranging alternative supplies. Priority was generally given to ensuring adequate availability for urban populations, i.e. market dependent populations, as it was assumed that rural populations would have either retained sufficient stocks or made other adequate provision for meeting its basic food needs (e.g. through the production of alternative drought-resistant crops such as cassava). Subsequently, it was realized that there were vulnerable groups within rural populations that should also be included when considering releases from the reserve.

Determining the need for a reserve, its size, and arrangements for its management and operation were set by the government, frequently with the help of aid agencies such as the FAO and bilateral donors. The physical establishment of the reserve was often an integral part of donor-supported programmes aimed at strengthening national food security. Typically, an initial quantity of grain would come from a donor, e.g. the World Food Programme (WFP), who expect that this would act as a catalyst for contributions from other donors. Grain from the reserve sold on the world market was expected to be replenished through purchases in the domestic market following the next harvest by the agency responsible for managing the reserve. Funding for these purchases was expected to come from monies generated from sales from the reserve. It was also expected that continued donor assistance would help replenish those quantities that had been distributed to vulnerable populations during food emergencies either for free or at subsidized prices.

Throughout the period from independence until the late 1980s, grain markets in most countries of the sub-Saharan region were strictly regulated by governments that tended to have a strong bias towards the politically more active urban populations. Low consumer prices were maintained by a combination of low producer prices and heavy subsidies. Pan-territorial and pan-temporal systems were the norm for both producer and consumer pricing, and private sector participation in the market was actively discouraged. Parastatals, or marketing boards, with monopoly rights for marketing designated cereals (and in some instances the provision of inputs), were established to administer the systems. They were also usually in charge of managing and operating the reserve stocks.[8] However, problems faced by governments in providing adequate funds to the parastatals to finance their operations often led to reserve stocks being used for normal market operations.

Financial pressures on both governments and the parastatals resulted in insufficient resources being made available to replenish the reserve stocks at the start of the following marketing year. At the same time, the donor community, facing increasing demands for food aid, was becoming steadily more disenchanted with the way reserves stocks were being used and grew unwilling to provide the resources necessary for rebuilding them. Progressively, the quantities held in reserves dwindled, and eventually ceased to exist in most countries.[9] Thus, for many countries the food security reserve, while continuing to form an integral part of the government's food security programme, tended to exist in theory rather than in practice.

Following the collapse of the socialist system at the end of the 1980s there has been a general move throughout Africa towards economic restructuring and market liberalization, leading many countries to introduce policies aimed at deregulating markets and encouraging private sector participation. Cereal markets, traditionally one of the most politically sensitive areas, were increasingly becoming involved in this transition process. Subsidy schemes were eliminated and governments progressively withdrew from intervention in the market.

To encourage private sector participation, parastatal grain companies lost their privileged monopoly positions and for the first time had to face competition in the market. Price controls were relaxed or eliminated, leaving market forces to set prices while other restrictions which had hitherto served as a barrier to market entry were abolished. However, because of its sensitivity, there was often concern in government circles as to whether a liberalized cereals market, driven by profit-motivated private sector traders, could adequately cater to the needs of the population. There was a reawakening of interest in governments regarding the role food security reserves could play in ensuring adequate availability of basic cereals in a liberalized market, and serve as insurance against the failure of the private sector making these provision, particularly in times of scarcity.

Initiating food security reserves

The mechanisms required for maintaining and operating a reserve under free market conditions are very different from those in a regulated market where the government, or

8 Food Security Reserve stocks were established in several sub-Saharan countries over the period 1975-1980s, e.g. Burkina Faso, Mali, Mozambique, the Niger, Ethiopia and the United Republic of Tanzania.

9 Notable exceptions to this generalization include the Malawian grain reserve and the reserves held as buffer stocks within the normal operational stocks of the parastatal grain agency (e.g. Kenya and Zimbabwe).

a government controlled agency, is the only official participant. Due regard must be given to ensuring that the basic requirements of a free market are not violated and that the operations associated with the reserve do not disturb the market's orderly functioning.

While food security reserves in different countries may have similar objectives and common features, their management and operation must take into account specific circumstances and government policy. Other influential factors may include: the likely cause and nature of food emergencies and the available mechanisms for coping with them, or the market structure and effectiveness of its participants to cater to market needs in food emergencies.

Once a decision has been made to establish a food security reserve, governments must consider the requirements and the various options available to them. Steps must be taken concerning the mechanisms required for monitoring market conditions and the ownership, structure, size, location and financing of the reserve.

Information requirements

In a regulated market system, the government, through various departments in the Ministry of Agriculture (e.g. extension and statistics) and parastatal agencies, were in a firm position to fairly reliably amass the information necessary to monitor the overall food situation in the country. However, under liberalization, control over the market shifts from the government's grasp into the hands of other participants, i.e. private traders. Under such circumstances the government must review its information requirements and sources so that it has a reliable overview of market conditions and prospects.

The quantity of grain marketed and stored (either on-farm or in traders'/millers' warehouses) in a free market context is unknown and impossible to obtain without a degree of imprecision.[10] Foreign trade arrangements made in the private sector would also be unknown unless special arrangements were made, for example through a system of import/export licensing. Governments are therefore increasingly forced to rely on secondary data to monitor the current and expected market conditions. This would involve using market prices, price trends and movements as a proxy for assessing market availabilities.

Thus, governments are dependent on the collection and analysis of statistical data to stay abreast of market conditions and to be able to assess likely future market developments. This requires focusing on the quality and reliability of production forecasts and developing market information and early warning systems. The less reliable the available information, the greater degree of uncertainty in predicting likely market developments, and thus more provisions will be necessary to ensure that needs will be adequately catered to.

Governments have traditionally been unwilling to make investments necessary for developing and maintaining effective information systems because of the firm belief that they cannot afford the resources. However, it should be remembered that such information systems can, by providing reliable data, help the government avoid the high costs of coping with an unexpected, or poorly prepared for, food emergency. Clearly, the reliability of the information systems will have a direct bearing on the size of the emergency grain reserve needed to assure the required degree of protection.

[10] Because producers in a free market tend to hold stocks on-farm in the hope of receiving a higher price later in the season, the quantities marketed at harvest are likely to be lower than in a regulated marketing system. These quantities are impossible to determine with any degree of accuracy. Also, for commercial reasons, private sector companies are unlikely to respond reliably to government requests concerning the grain stocks they are holding.

Crop production forecasts Estimates of the production of key crops are usually made during the growing season based on area planted and expected yield. These estimates are finalized after the harvest when the results of crop cutting surveys are normally also included in the calculations. However, the reliability of these estimates varies considerably between countries. Armed with this information, the government is in a stronger position to assess the probability of food shortages arising and the likelihood of demands placed on the food security reserve.

In most countries, past neglect and/or under-resourcing have resulted in relatively unreliable crop forecasting systems. Governments must therefore pay attention to strengthening their crop forecasting systems to improve both timeliness and reliability of information. In some countries, various agencies may be involved in preparing independent crop forecasts. This often leads to substantial variances that can be difficult to resolve. The situation can be complicated by interdepartmental rivalries resulting in reluctance to accept information prepared by others.

An alternative to consider is appointing a single authority to prepare consolidated crop forecasts. The authority would be mandated to bring together those agencies/departments currently engaged in estimating crops, or to usefully contribute to the estimating process by providing appropriate information and to jointly develop a coordinated and consistent approach to crop forecasting. The authority would be responsible for assessing the information provided by each agency/department and for preparing a consolidated forecast. Ideally, mechanisms should also be established for comparing forecasts with the subsequent observed results with the objective of identifying reasons for any significant variance so that procedural adjustments can be made to improve the reliability of future forecasts. Currently such post factum reviews are rarely if ever undertaken.

Market information systems Market transparency is of fundamental importance for the efficient operation of a free market. It requires that information about prices and availabilities in key markets throughout the country are readily available to market participants, i.e. producers, traders and retailers. The availability of this information stimulates market users to exploit spatial price differences by moving produce from low to high priced markets, in other words, it encourages arbitrage, and, despite inter-market handling costs, it leads to equalization of prices between markets. Governments must give high priority to the establishment of a market information system (MIS) that will provide by both governments and traders regular information through media about prevailing market prices and availabilities.

Such a system may also be extended to include market intelligence, particularly in the government's assessment of the country's food situation (e.g. information about production, market demand, estimates of import need or export potential, international prices other information of general interest to the trade). Wide dissemination of such information by the government to traders will help all make more informed judgements of market requirements, thereby improving the efficiency with which the market operates. Such improvements in market efficiency will confer a direct benefit to the government by reducing the provisions it must make to cover any weaknesses in the marketing system.

Crucial to the efficacy, and hence success, of an MIS is the speed with which information is made available to potential users. Common criticisms of the MIS include the problems inherent in organizing the regular collection of price and availability information from selected markets as well as the cost of collection, especially if special teams are employed. These costs can be minimized if the responsibility for collecting information in a standardized format is transferred to the market authority, often the municipality. The cost of collection can then be recouped through the system of market fees. In this way the users of the market, who are also the main beneficiaries of the information disseminated, would be responsible for covering the costs of collecting, and possibly also processing and disseminating, the information. The service could therefore become self-financing. The information collected in the selected markets would be transmitted directly to a central agency, usually based in the Ministry of Agriculture, which would process the data and then retransmit it to the markets, media and subscribers. The central agency would be responsible for the following: determining the data to be collected, designing a standardized format for the ease of collection and processing, and training and monitoring the data collectors to ensure that they follow established procedures.

Early warning systems Many countries susceptible to food emergencies have established early warning systems for gathering together all of the information that has a bearing on the current and expected food situation and for preparing regular reports assessing the prevailing food situation and its prospects.

Information used for early warning assessments is brought together from a variety of sources including remote sensing, agro-meteorological information (particularly rainfall data) and crop forecasts. The timing of interpreting this information can play an important role in alerting governments and traders to the likelihood of food shortages occurring later in the food year or in the following food year. With such advance warning there should be sufficient time for the government or responsible public agencies (such as the agency responsible for the food security reserve) to take appropriate actions to cope with a pending emergency.

Again, the reliability and timeliness of such information has direct bearing on the size of the reserve required. The better and more reliable the information is with respect to giving advance warning of foreseeable events, e.g. drought or global market turbulence, the lower the requirement for the reserve.

Composition of the reserve

In an ideal world, a food security reserve would comprise a range of cereals reflecting the preferred staple of the potentially vulnerable population. However, such a benevolent approach can cause problems, albeit inadvertently, which not only increase the cost of establishing and maintaining the reserve, but could also increase the vulnerability of some rural population groups to food insecurity. For example, this may occur if populations become accustomed, through releases from a reserve, to a grain type which is agronomically unsuited to the area (e.g. white maize in drought prone areas), or whose normal market price is beyond the population group’s normal purchasing power (e.g. rice).

As a basic principle, a food security reserve should comprise cereals that are widely consumed, normally readily available in the domestic market, and preferably locally produced. In selecting the grain type (or types) for the reserve there will always be a trade-off between which grains are preferred by the potential beneficiaries and their cost relative to an acceptable alternative. For example, while, for social reasons, consideration may be given to holding some quantities of rice in reserve, because its cost per tonne is historically double that of white maize, sorghum and millet, and its nutritional value is not markedly higher, it is difficult to justify a rice component. The cost of establishing and maintaining the reserve is also likely to be higher when it contains several grain types, as the need to maintain different stock combinations in different areas will increase demands on transport, handling and administration. Thus, from a purely cost and operational standpoint, it would be advantageous to have only one type of grain in the reserve, e.g. white maize, as has been the case for most African countries to date, rice in Far East countries and wheat in the Near East.

Establishment of the reserve

Establishing the reserve requires either the provision of finance or the direct provision of grain from donations. It is to be expected that whichever method or combination of methods is used, the reserve will not be fully resourced from the outset, either in terms of cash or stocks, but rather will be built-up progressively as additional resources are made available by government or perhaps by donors. Additional resources may be generated periodically from profitable sales of the reserve. However, these should be considered as windfalls rather than as a regular feature, as reserves are normally considered to be a cost centre requiring periodic injections of cash rather than a profit centre. Thus, for the first few years of operation, purchases are likely to be limited not by the size of the reserve, but rather by the finance available to purchase grain.

Purchase of grain

Accordingly, a prime concern for the management and operation of the reserve should be ensuring that transactions have as little effect on the orderly functioning of the grain market as possible. Specialist reserve agencies are not regular purchasers in the market, as are normal traders; they only enter the market occasionally, usually immediately after a harvest, to make purchases to replenish the reserve. Under these circumstances, it is not advantageous for an agency to set up structures where it is required to purchase directly in the market in parallel, or in competition with, established traders. It would normally be preferable for the agency to either appoint agents to purchase grain on its behalf or use a tendering system. Both of these options harness the skills and energy of the private sector while saving the agency from having to establish and staff its own purchasing structure that would only be required infrequently. By using existing market participants in their normal roles, reserves do not distort the normal functioning of the market except by creating increased demand.

In addition to purchasing grain on the domestic market, reserves may also need to consider purchasing grain on the international market. Under such circumstances, trying to make significant purchases in the domestic market may well cause prices to rise even faster. The extent to which the reserve agency would need to enter the international market would, in turn, depend on the extent to which the private sector is encouraged to import directly on its own account to make good any shortfall. Apart from concerns over not wanting to over-import, other constraints may limit the private sector's ability or willingness to import. These concerns include: difficulty in gaining access to foreign exchange for purchases, lack of experience in importing substantial quantities, small scale of operation of many private sector traders and concerns over possible government interventions. In these cases, the government may wish to provide some mutually advantageous support to the private sector. The government could, for example, act as an intermediate importer or enter into arrangements with commercial banks to underwrite part of the loans for grain imports.

A more advanced option a reserve agency/government may consider is employing other financial instruments for covering all or part of the import needs. Futures and options may be used either to hedge positions or to provide a form of insurance. However, a word of caution is required. While these strategies can considerably help lower costs in a commodity market, they can also lead to substantial financial losses if not used properly. Detailed knowledge and experience of the international market is essential to take advantage of such systems. In most countries this expertise is not readily available, and agencies considering using these or similar instruments should seek the advice of a reputable trading firm or independent broker.

Size of reserve

The target size of a food reserve has traditionally been determined on the basis of the vulnerable population's cereal requirements during the time-frame between the recognition of an imminent food emergency and the point at which additional supplies can be distributed, i.e. the lead time. For the purposes of calculation it was typically assumed that the cereal requirement was equivalent to some 160-175 kg per person per year and that a lead time of three months would be required to organize and receive additional supplies. The resultant size for the reserve was held static at this level until circumstances were considered to have changed and the calculation was repeated. Usually, recalculation occurred only after several years.

The above-mentioned method for determining the size of reserve stocks assumed that the consumption pattern of the affected population would remain constant and that the so called "food gap" - the difference between availability (production and opening stocks - and consumption requirements - would be filled by a combination of stock reduction and imports. However, in times of food shortages people change their eating habits by switching to alternative foods, e.g. cassava and other root crops instead of maize, or, in extreme cases, by eating less and thereby reducing the demand for the staple food. Thus, there is a tendency to overestimate the size of the food shortfall and consequently the size of the reserve required to cope with it. To avoid this pitfall, determinations of appropriate reserve size must take into account the likely extent to which vulnerable households will switch to alternative foods.

However, by maintaining large reserve stocks on a continuing basis, including during years of good harvests when it is unlikely that a food emergency will arise, the government is asked to bear a needlessly high cost. This is particularly the case for those countries where high interest rates which, under the terms of their structural adjustment programmes, can no longer be subsidized. There is therefore a need to consider alternative methods of maintaining a reserve that will acceptably cope with food shortages while being less financially demanding.

Key factors used by governments in the past to determine and administer the country's food needs were knowledge of the quantity of grain marketed and control over these stocks. Today, governments have neither the knowledge nor control over marketed grain stocks. Instead, they determine market prospects and the likelihood of an emergency by depending on secondary information such as prevailing market prices or market availabilities and price trends. The situation is further complicated for those countries which oscillate between surpluses and deficits, particularly when traders are also involved in importing and exporting grains. Under such circumstances, the government is not necessarily aware whether adequate provisions have been made by the private sector to cater to the country's import needs. To properly monitor the situation, an effective information system, is, as discussed earlier, of paramount importance.

The cost of establishing and maintaining a grain reserve is directly related to its physical size. Reducing the average size held would result in a lower cost to government. This could be achieved without jeopardizing the ability to adequately cope with the initial stages of a food emergency as long as the programme adopts a policy of adjusting the reserve size according to the prevailing circumstances rather than attempting to maintain a fixed size irrespective of the circumstances.

Within sub-Saharan Africa, the most likely cause of a major food emergency has historically been drought. The implications of a drought on domestic grain production, and therefore on the grain availability in the following marketing year, should be recognized well before harvest. As there is rarely a total crop failure, the impact of the drought on the availability of grain in the market will likely only start to be seriously felt after 3-4 months into the next marketing year. Initially this would be evidenced by higher real market prices for grains, with a possible increase in demand for alternative foods, coupled with prices starting to rise earlier than normal in the marketing year. There should thus be a warning period of at least six months before a likely food shortage. This should provide an adequate lead time for governments to make a reliable assessment of the shortfall size and initiate measures necessary for coping with the situation. By adopting this approach, the physical size of the reserve could be adjusted each year in accordance with the perceived needs. Thus, in years of good production or surplus, when the demands on a grain reserve are likely to be low, the size of the reserve would be reduced. Conversely, in years of poor production, e.g. as a result of drought, the size of the reserve may be increased to enable it to cope with the likelihood of a food shortage.

Box 25.1: Ethiopia: the emergency food security reserve administration

The management of Ethiopia's food security reserve, originally created in the 1970s, became the responsibility of an autonomous unit of government, the Emergency Food Security Reserve Administration (EFSRA) in the late 1980s. The creation of the EFSRA was widely supported by the Ethiopian government, donor agencies and NGOs involved in distributing food aid to the country's various relief and development projects. Over the past 20 or so years, and after a number of reviews of the reserve's structure and function, its capacity has steadily increased from around 180 000 tonnes to 307 000 tonnes in the early 1990s to the current level of just over 400 000 tonnes. The EFSRA, with headquarters in Addis Ababa, is responsible for large bag warehouse storage facilities at seven locations: Dire Dawa, Kombolcha, Mekelle, Nazareth, Shashemane, Wereta, Woliyta and Sodo.

Currently, the EFSRA, despite its title, has less to do with dealing with emergencies and more with smoothing the flow of food aid to relief and development projects. Effective response to emergencies must be prompt and immediate, yet food aid deliveries may take some considerable time to organize. EFSRA stocks have therefore provided a convenient and necessary means of bridging the time between government and donor responses to emergencies and the arrival of consignments of food aid. Agencies can draw stocks from the reserve against pledges to repay similar quantities of food grain within an agreed time.

The reserve was initially established entirely with stocks of imported grain. However, since the mid-1990s the quantity of domestically produced grain entering the reserve, especially maize and sorghum, has been increasing steadily. Food aid agencies may distribute locally procured grain directly to beneficiaries, but most of the grain is delivered to the reserve to repay loans. The arrangement is not without problems. When stock levels in the reserve are high and warehouse space is at a premium, extended delivery routes and high transport costs for locally procured grain may occur. For example, the only available warehouse space for maize procured in the south of the country may be at an EFSRA site in the north.

Raising the level of locally produced grains in the reserve increases the risk of quantitative and qualitative loss. Fortunately, the EFSRA has received considerable donor support (technical assistance, training and equipment) and is able to maintain stocks in satisfactory condition for human consumption over extended storage periods. It is widely acknowledged that the EFSRA maintains a high standard of storage management and that losses owing to pests and spillage are contained below 1 percent annually. Source: Walker & Wandschneider (2005).

Such a system of a variable, or dynamic, reserve size requires that an annual review be undertaken by the responsible government agency (the Early Warning Unit, for example) to determine the food prospects for the coming marketing season. Normally this would be done some 2-3 months prior to harvest, i.e. when reasonable forecasts of crop production should be available. This review would then form the basis for the responsible agency's governing body to decide on the size of reserve required for the coming season. Because of the number and variability of the factors involved, many of which are non-calculable, e.g. the quantities of grain which will be imported by private sector traders or the extent of a switch to alternative foods, size determination must be made on the basis of reasonable assumptions and past experience. It should, however, be remembered that the size can always be adjusted as new, or improved, information becomes available. Even within a season the reserve size should not be immutable, but rather be in a continual state of adjustment to meet arising circumstances. In determining the size for the reserve certain principles should be observed. For example:

- There should be a minimum size for the reserve to act as an insurance against unforeseen circumstances. Initially this could be set at about one month's market requirements;
- While there should be no maximum size for the reserve, it should generally not be greater than the quantity required to meet the market demand for the lead time needed to arrange alternative supplies.

Just as the quantities required for the reserve vary from year to year, so do the financial resources required to purchase and maintain the reserve. This means that either the government must make provisions for a variable level of funding each year, or the responsible agency must be allowed to hold and operate funds on a continuing basis. In the first instance, the reserve would need to make an annual budget request for the funds required to bring its stock to the determined level. This may cause problems for the allocation and release of funds due either to financial constraints on government or to the fiscal year not coinciding conveniently with the crop year, i.e. at the time that government budget allocations are made the requirements for the reserve may not be known. If the reserve agency administers the funds, the necessary purchases may be made as soon as and when required (up to available limits) without recourse to the government.

By using this system, the reserve would hold varying combinations of physical stock and cash, with the cash component representing the residual financial resources available for the purchase and maintenance of stocks after the needed stocks have been purchased. Thus, in years when there is surplus production and the likely demand on the reserve is low, the physical stock would be correspondingly low and the cash account high.[11] The reverse situation would apply in years when poor harvests or high urban prices could lead to food shortages. Depending on the ability of the reserve agency to regenerate its funds from releases onto the market, it may be necessary to periodically request governments for additional funds to finance grain-buying operations. This is more likely to occur in years of poor production when larger reserve stocks are required and domestic grain prices are likely to be higher.

11 These funds should be kept in a deposit-bearing account, preferably in foreign convertible currencies. This would enable the agency to protect the value of its funds against the risk of local currency devaluation, and also to have funds available to purchase on the international market if necessary.

Location of the reserve

There is often a discussion as to whether it is better to hold physical stocks of grain in the area of production or in the area of consumption. From a pure cost point of view, it is cheaper to hold grain in the area of production rather than transfer it to areas of consumption. In this way, the costs of transport and handling are kept to a minimum and are only incurred as and when it is clear that the grain is required at a particular place. However, reality rarely lives up to theory. Reserves must be held in locations where suitable facilities with adequate capacity for long-term storage of significant quantities of grain exist. As a result of past marketing policies, which were heavily biased towards the needs of urban consumers, modern storage facilities, bag stores and/or silos, are often located in, or within easy reach of, main urban areas.

Many of these facilities become increasingly under-utilized during market liberalization, as the storage pattern changes to take into account new market conditions. More grain will remain on-farm, as producers try to benefit from the higher prices towards the end of the season. Storage demand by private traders is also likely to be low, as traders tend to operate on the basis of rapid stock turnover and small margins rather than on the purchase and storage of grain. Thus, while suitable storage capacity should not be a problem, the location of the reserve will be dictated in the first instance by the location of existing available storage facilities.

While there may be advantages to spreading the reserve across several locations, consideration must be given to maintaining control and supervision over physical stocks. The more fragmented the reserve becomes through storage in different locations, the higher the cost for monitoring stock integrity, and the greater the likely need for subsequent movement. There are therefore advantages to restricting the reserve to a few strategic locations that can be readily monitored and supervised.

Management of the reserve

Although the main function of a food security reserve is social/humanitarian in nature, there are often political connotations at play. Basic principles for reserve management and operation can be established, but the social, and possibly political, implications of food shortfalls can be extremely sensitive. Thus governments generally want to retain some powers of discretion over the use of reserves. This is particularly the case when such decisions cause the government to incur additional costs. The extent to which the government would want to, or should, exercise such control varies from country to country. In designing the reserve's overall structure, it must be decided which responsibilities will be retained by government and which will be delegated to the agency charged with the reserve's management and operation. The main responsibilities that should remain under government control are:

- Monitoring the performance of the entity charged with managing and operating the reserve and taking the necessary action to correct adverse trends;
- Ensuring that the entity is acting in accordance with its approved mandate;
- Monitoring the efficiency with which resources entrusted to the reserve are being utilized;
- Reviewing the audited accounts of the reserve's activities;
- Modifying or otherwise adjusting the entity's mandate, i.e. its authority and responsibilities, to meet changing circumstances;

- Authorizing actions to be undertaken which involve the government incurring additional costs, i.e. increasing the resources available to the reserve, sanctioning releases of grain for relief actions.

As a guiding principle for determining the responsibilities remaining with government, care should be taken to avoid allowing the government to use its authority to interfere directly in the reserve's management. This is particularly important with respect to directing or promoting social actions that may be interpreted as having political objectives, or other actions that could have a damaging impact on the functioning of the free market. Decisions of a purely operational nature should be left to the responsible entity. To preclude future misunderstandings between the government, the concerned entity and traders involved in the reserve's functioning, it is advisable to clearly specify the responsibilities in an Operational Procedures Manual. This would, *inter alia*, provide a clear distinction between respective roles and thereby help ensure that government interference is minimized.

Within the government, institutional responsibility for the reserve may be vested to: a high level committee composed of senior officials from relevant ministries, e.g. the Ministries of Agriculture, Food, Finance, Home Affairs and Health, or the office of a senior minister or designated government department, e.g. the Food Security Department.

Routine operational activities such as warehouse management would normally be under the direct control of the responsible agency. However, it may be considered necessary for a more senior authority to sanction activities related to the reserve's integrity, or those that could impact the market.

The need for operational procedures

The importance of standard operational procedures increases substantially when competitive market functioning is at stake, which otherwise could be perceived by private traders as a potential threat to their market activities and thus decrease their willingness to invest in the food system. To avert any residual apprehension that the reserve may be used as a tool of the government to manipulate the market, there must be transparency in operational decisions and general understanding and acceptance of their manner of implementation. The greater the opacity of operational actions, the more divergences or inconsistencies in applying declared procedures, the more cautious and distrustful private traders will be of the government.

In addition, by maintaining the identity for the reserve, the government's official recognition of an approaching food emergency will assure the donor community that the reserve is only being used for the intended purpose of assuring food security.

Both government and private sector participants must recognize the significant advantages to having clearly designated procedures that specify how, and under what conditions, operational decisions relating to the reserve will be made and implemented. For example:

- the agency responsible for managing the reserve may be held accountable for its actions. This is likely to result in less abuse in reserve use and operation;
- the private sector will be fully aware of the circumstances and manner in which the reserve will be used. This should encourage them to assume, with confidence, an increased role in the marketing of grain, particularly if they are to be involved in some of the reserve operations, e.g. purchasing and storing grain;
- aggrieved parties in the private sector will be able to take the government to task if established operational procedures are circumvented;

- governments will find it more difficult to countermand established operational procedures for their own expediency or political advantage;
- greater private sector confidence and involvement will narrow the difference between market needs and the provision made by the private sector. This may, in turn, reduce the size of the reserve the government must maintain to achieve a particular level of security.

To avoid any confusion or misunderstanding, it is useful to prepare, preferably in consultation with representatives of private sector traders, an operational manual containing a comprehensive set of procedures and actions for managing and operating the reserve. Such a manual would describe:

- the structure, authority and responsibilities of any committees or governing bodies of agencies associated with the operation and maintenance of the reserve;
- the structure, authority and responsibilities of the agency responsible for administering the reserve;
- general information relating to the ownership and purpose of the reserve, such as its size, location and financial arrangements;
- conditions for triggering releases of grain from the reserve for various activities; and
- procedures for:
  - release of grain from the reserve;
  - procurement of grain for the reserve;
  - storage of grain in the reserve;
  - recycling grain in the reserve; and
  - financing reserve operations.

The responsible agency may contract out the reserve storage to either a public or private sector organization with access to suitable storage facilities and expertise in grain storage. This would remove the need for establishing the capacity for direct day-to-day management of the grain stocks. This is also likely to be the lower-cost option, as the agency would only be required to pay for the actual storage capacity used on a cost per tonne per month basis, rather than having to bear the total cost, whatever the capacity used, if it owned and operated the facilities itself. This would be particularly relevant in those countries which vary the size of the physical stock held in the reserve each year, depending on the perceived risk of a shortfall occurring, and therefore the annual storage capacity requirements. If the preferred option is to own and operate the storage facilities directly, arrangements need to be made for transferring ownership or responsibility for the required storage facilities to the reserve agency.

Procurement

The quantities that can be purchased for the reserve will depend on the funds available and the average price per tonne to be paid. To maximize the quantity purchased for a given level of funding, procurement efforts would normally be concentrated in the period immediately following harvest in the main surplus producing areas when market prices can be expected to be at their lowest. Purchases during this period may also have the beneficial effect of increasing demand, thereby providing some support to producer prices at a time when market prices are low. However, depending on market availabilities and sensitivity to changes in demand, it may also be desirable to spread purchases out over a several month period to avoid putting a large demand on the market for a short period of time, and thereby risk causing further price instability.

A promising method for purchasing grain is through a contract, which can either be negotiated directly with a trader or as the outcome of a successful bid in an open public tender. Both methods will result in the supply of grain in an agreed quantity and of a specified quality to be delivered to a nominated location within a stated time frame for an agreed price. Open public tender offers the advantage of transparency and avoids the risk of accusations of unfair competition and collusion between the reserve agency and the contractor, as could be the case when direct contracts are negotiated. Open public tenders would normally be floated by the reserve agency through advertisement in the press inviting bids.

Recycling

To maintain the reserve in good condition, it will be necessary to periodically rotate the grain that has not been required to meet a market shortfall or for relief programmes and is still held in the reserve. While, under the prevailing climatic conditions, it may be possible to hold grain satisfactorily for longer than a single marketing year, it will, even under the best storage conditions, have suffered some deterioration (e.g. shrivelling) as compared with fresh grain. This will lower its acceptability, and thus its price relative to fresh grain, in the marketplace. Therefore, unless there are overriding reasons for retaining the grain for longer than one season, for instance if crop forecasts indicate that there will be a shortfall in production, it would normally be advisable to rotate the residual stocks held in the reserve each year.

Releases

Releases from the reserve will generally be made to counteract market access problems signalled by high and/or rapidly rising prices, and for disaster relief operations. To enable the reserve to fulfil its function, mechanisms must be in place for signalling the need to release grain. While various triggers for releasing grain can be devised for coping with market shortfalls, releases for relief purposes are more difficult to determine and should, because they involve direct cost on government, be sanctioned by the government department responsible for relief programmes.

A typical trigger to initiate the process for releasing grain into the market is when the market prices rise exceptionally rapidly over a 2-3 month period. The definition of "exceptionally rapidly" would depend on what is considered to be the normal seasonal price pattern for a particular commodity and will vary between countries. For example, it might be considered normal for prices to increase at 10-20 percent per month in the middle of the marketing season, however, price rises of 40-50 percent per month over a period of two months would be considered abnormal, and this could signify market shortages necessitating action by the reserve agency. Releases should be made progressively so that their impact on prices can be monitored.

Because the private sector is profit-motivated, any grain it imports will be destined for sale in the market. It would be unrealistic to expect private sector traders to import grain also to meet the needs of vulnerable groups who do not have the resources to purchase grain in the market at the prevailing price. This is a social responsibility for which governments must make separate arrangements, e.g. food for work, food stamps. Traders are also likely to err on the conservative side when arranging imports. For example, they will tend to under-import rather than over-import to avoid being left with high cost stocks at the end of the marketing year when prices can be expected to fall as the new crop comes into the market. Therefore, it may be that the responsibility for ensuring that the market is adequately supplied rests with governments through releases of grain from the reserve to make good the shortfall of private sector imports. Additionally, the government will continue to be responsible for making provisions through releases from the reserve to meet the needs of those transitory food insecure who are unable to access the market.

Financing the reserve

As the food security reserve is a public institution, it must ultimately be the government that finances the cost of establishing and maintaining the reserve. From the outset it should be recognized and accepted by government that the reserve is likely to be a continuing cost burden. The scale of the costs involved will be related to the size of the reserve and the obligations for social programmes. For those countries where the majority of releases will be for meeting shortfalls in market availabilities, the cost to government is likely to be proportionately lower than for countries where high rural vulnerability to food insecurity is combined with low purchasing power, thereby necessitating increased use of relief programmes. The management and operational structure of the reserve will also have a bearing on its costs.

Costs attributable to the reserve are likely to increase when:

- the reserve agency is responsible for maintaining and operating the storage facilities used for holding the reserve, e.g. recurrent staffing and building costs will be incurred irrespective of the quantity of grain held in the reserve;
- the reserve agency is responsible for maintaining the physical stocks held in the reserve;
- the reserve comprises several different types of grain. In this case some grains will be more expensive than others, and higher administrative, handling and transport costs are incurred (e.g. various grain types must be allocated to different locations where they will be required);
- purchases are made directly by the reserve agency, as the reserve agency will need to establish and maintain the capacity for undertaking such actions, which are only required intermittently; and
- the reserve agency is also responsible for monitoring market conditions and providing market intelligence activities.

Costs are likely to decrease when:

- other government agencies are responsible for monitoring market conditions, e.g. Early Warning Unit and Market Information, and/or Market Intelligence Systems;
- the storage and maintenance of the reserve is contracted out, because the agency would only be required to pay for storage and maintenance of the grain actually held. A private sector company may use the "spare" capacity for storing other commodities either on its own account or under contract for other traders;
- the reserve comprises a single, locally available grain; and
- purchases are made using the facilities and resources of the private sector, i.e. buying and selling by public open tender or through appointed private sector agents or using commodity exchanges.

While the reserve is likely to be used for the most part to cope with market shortfalls, there will be occasions when it has to be used for relief programmes for those groups who do not have the necessary resources to purchase their requirements in the market. In these instances grain will usually be released for distribution through a food-for-work or a special feeding programme. Unlike releases for sale in the market, which can be triggered by predetermined factors, releases for relief programmes must be decided on a case-by-case basis. As such programmes are of a social nature, and therefore require financial support, they will need to be authorized by government and charged to the appropriate government department.

Regional reserves and other food security instruments

There are other diverse instruments that can serve as a first line of defence in the event of a food emergency. A salient feature of any instrument should be to ensure that food supplies can be rapidly released to those most at risk of a global or localized crisis, while minimizing distortions to the functioning of markets (including prices). Once the crisis dissipates it is imperative that markets resume their normal functioning.

WFP's forward purchase facility [12]

The World Food Programme (WFP) started advance financing of operations in 1999, when the Direct Support Costs Advance Facility was established. In 2004 the agency piloted a "Working Capital Financing Facility" using an operational reserve as leverage to advance up to USD 180 million to operations, allowing food to be procured before a contribution to a project had been confirmed. Traditional advance financing has been used by 52 country offices to improve delivery times of 1.2 million tonnes of food to 70 million beneficiaries. The number and size of such loan requests have increased dramatically since 2004.

In 2008, USD 60 million from the Working Capital Financing Facility was used for a pilot Forward Purchase Facility (FPF) to enable WFP to buy food based on estimated aggregated regional needs and funding forecasts to further reduce lead times for the delivery of food. The initiative was targeted towards emergency needs in the Horn of Africa and southern Africa. To enable WFP to gain experience and prove the concept, the parameters of the pilot were simplified to focus on procurement of cereals from South Africa and the Black Sea region. During the initial phase, 315 000 tonnes of cereals were purchased - much of it during the harvest period - and allocated to operations in southern Africa and the Horn of Africa.

Although baseline data was not maintained to track cost and time savings for each consignment of forward purchase, they were estimated by the Secretariat on the basis of 149 135 tonnes of food delivered through the Facility (see Table 25.1): the consignments were delivered on average 53 days earlier than normal and saved the WFP USD 1.3 million - 3.4 percent of the costs. The WFP did not incur additional storage expenditure because the food was delivered to the projects at the right time.

The WFP seeks to purchase food at favourable times at advantageous prices, but there is no certainty that the FPF will generate savings in food purchases because markets are unpredictable. But savings are not the facility's primary objective. The aim is to reduce lead times for delivery to beneficiaries at times when food is urgently needed.

A major reason for the early success of the FPF pilot was that collaboration among country offices, the Southern, Eastern and Central Africa Regional Bureau, the Kampala sub-regional office and Headquarters units for budgeting, programming, procurement, logistics and resourcing, ensured timely deliveries of food to beneficiaries and reduced the risks for the WFP.

Building on the pilot projects, the WFP expanded the FPF food basket to include rice, pulses, and corn-soya blend in smaller quantities in order to provide a nutritionally balanced ration. When food was not readily available in a region, the FPF was used to procure it on international markets, which reduced lead times. The FPF was also expanded to West Africa in early 2010 to help address the Sahel crisis, and to Asia for the forward purchase of rice.

[12] Adapted from WFP (2010).

Table 25.1: Comparison of maize purchases from South Africa using the FPF compared with forecast contribution

Purchases through FPF	Recipient country	Prog. category	Country allocation	Price per mt - FPF	Revised price per mt - WCF Facility	Savings \losses	Days saved
Dec-08	Zimbabwe	PRRO	5 200	269.00	279.76	55 952.00	33
Dec-08	Kenya	EMOP	14 646	269.00	279.76	157 590.96	51
Dec-08	DR Congo	PRRO	1 639	269.00	279.76	17 635.64	63
Dec-08	Zimbabwe	PRRO	10 000	274.80	285.79	109 900.00	32
Dec-08	Zimbabwe	PRRO	1 950	274.80	285.79	21 430.50	33
Dec-08	Kenya	EMOP	1 550	274.80	285.79	17 034.50	54
Dec-08	DR Congo	PRRO	9 485	277.00	287.99	104 240.15	65
Dec-08	Kenya	PRRO	5 515	277.00	287.99	60 609.85	53
Dec-08	Zimbabwe	PRRO	3 150	281.00	292.24	35 406.00	34
May-09	Kenya	EMOP	10 000	290.00	275.50	- 145 000.00	61
May-09	Somalia	EMOP	8 532	290.00	275.50	- 123 714.00	63
May-09	Kenya	PRRO	9 941	290.00	275.50	- 144 144.50	52
May-09	DR Congo	PRRO	1 527	290.00	275.50	- 22 141.50	63
Jul-09	Kenya	PRRO	15 000	199.00	222.80	357 000.00	53
Oct-09	Somalia	EMOP	14 721	212.51	242.26	437 949.75	61
Oct-09	Kenya	PRRO	15 279	212.51	242.26	454 550.25	54
Oct-09	Somalia	EMOP	5 000	398.00	453.72	278 600.00	59
Nov-09	Somalia	EMOP	15 000	234.00	208.26	- 386 100.00	58
Oct-09	Somalia	EMOP	1 000	400.60	456.68	56 080.00	61

Ensuring food security with value chain call options [13]

The enormous challenge in terms of food security comes when markets are not in equilibrium. Crisis in international markets, domestic food shortages and gluts can strain value chains to the extent that they no longer function efficiently or, in the extreme, become redundant.

In times of food surplus, the very design of the value chain should ensure that incomes are sustained, because many indigenous foodstuffs - especially root crops like cassava and potato - can be transformed into a host of high-valued products. However, in times of basic food shortages, farmers may be compelled to break contractual arrangements by side selling, or their raw material may become the target of government intervention to bolster food security. There are market-based interventions to value chains that could strengthen food security in times of crisis. One such instrument is the use of options, as discussed in Chapters 19 and 20. Recall that an option is a contract between a buyer and a seller that gives the buyer the right - but not the obligation - to buy or to sell a particular quantity of a commodity at a later day at an agreed price. In the context of food crisis management, the buyer would be a food authority while the seller would be the producer in the value chain. The basic idea is that when food shortages are declared, the authority exercises the options contract to divert predetermined quantities of the raw material for basic food supply at affordable prices, while paying farmers the prevailing contract price agreed with the value chain processor (see on a similar idea the proposal in Chapter 23). The decision to declare the shortage should rest on an independent authority, such as the WFP.

An insurance plan could be sought by the authority that would compensate processors for the loss of revenue, i.e. the incremental profit from transforming the raw material to the processed product. Alternatively, those processors who are sufficiently diversified in raw material use (i.e. they are involved in other agricultural commodity value addition) would be permitted to enter the scheme. The authority also could hedge against the cost of the scheme by taking out options on an international or regional commodity exchange, such as SAFEX of South Africa.

It is assumed that organized, sophisticated exchanges do not exist in the country undergoing the food crisis. The volumes purchased should be made transparent to the public, so that private food traders can factor possible market impacts of such state interventions into their commercial calculations. Of course, the scheme may be modified and fine-tuned, but the basic premise stands: value chains and their proper coordination can provide incentives for productivity-raising investments, foster higher incomes to participants and, during times of crisis, market-based interventions to the value chain can produce non-distortionary impacts that enhance food security and bring long-term stability and sustainability to food systems.

Self-targeted strategies[14]

Countries that do not wish to subsidize a large portion of food consumption, but instead aim to target the most vulnerable, can design such policies while encouraging participation of the private sector in their food markets. For example, Egypt's policy of making coarse baladi bread available at a low fixed price is an example of a self-targeting strategy, which limits leakage of food assistance to those consumers not in need. If public aid is restricted to a commodity favoured only by the poor or desperate, it can leave the rest of the market to the private sector. The public distribution system can be used as a major part of a strategy to

13 Adapted from FAO (2010).

14 Adapted from Wright (2010).

"roll over" strategic stocks and keep them viable while minimizing the impact of sales from stocks on the private market. During emergencies the poor can be targeted by pre-planned "food for work" programmes with below-market wages, and by distribution of food in a form not attractive to those who are wealthier.

Conclusions

Food security and emergency reserves have received widespread policy attention following the 2006-08 high food price episode. A food security reserve that responds quickly to emergencies would help speed up responses of governments and international organizations in aiding groups in distress. The free market cannot be relied upon to service this need, because the effected groups lack the resources to bid for the food they need.

Key to the success of such reserves emanates from programme design. First, the organizational structure and management of the reserve must reflect a high level of commitment from the part of governments and aid agencies, supported by clearly defined rules of procurement and distribution. Second, and of equal importance, the procurement and release of food should have minimal disruption to regular market functioning. Also, the presence of the reserve should not "overhang" markets. An overly copious reserve could undermine the confidence and ability of the private sector to invest in grain marketing. Scaling down the size of the reserve to reflect optimum working efficiency would ensure that these uncertainties are allayed.

Food security reserves at the national and international level constitute just one measure to ensure that food supplies are at hand when most needed. Other market neutral instruments purporting to a similar objective include the use of value chain call options on indigenous crops such as roots and tubers. A growing recognition of their amenability to value addition and that such crops are not internationally traded will ensure that they will be potentially locally abundant in times of food emergencies. Self-targeted strategies that distribute income-inferior foodstuffs in times of emergency are also a promising and sustainable relief instrument.

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Targeting the most vulnerable: implementing input subsidies

Zoltan Tiba[1]

Input subsidy programmes are again on the agenda in donor policies after being ignored for at least two decades. The resurgence of interest in subsidies has been the result of several factors including failures of liberalization policies, stagnation of agriculture, declining soil fertility, deteriorating livelihoods of poor rural households as well as rapidly increasing food and fertilizer prices. This "new generation" of input subsidies includes so-called "smart" subsidies which favour market-based solutions and aim to promote development of agricultural input markets while targeting and enhancing the welfare of the poor. They have wider objectives than universal subsidies and focus on agricultural development, economic growth, social protection and food security. Subsidies generate interrelated impacts on prices of inputs, production and prices of staple crops, rural wages, market development, as well as growth and social development. However, smart subsidy programmes may have adverse impacts such as distortion of the market or leakage to better-off farmers, which should be avoided at any cost.

This chapter focuses on "smart" subsidies and provides operational guidelines for methods of implementation. Under "inputs" I focus primarily on fertilizer and consider social protection and an increase in staple food production as the primary objectives. Smart subsidies differ from universal subsidies in several ways, therefore their implementation requires pursuing alternative objectives such as targeting the poor, harmonizing with other policies, setting the level of subsidy and not harming the private sector.

Background

Economic prosperity and social development have long been linked to agricultural productivity in developing countries. Market-smart agricultural input subsidies can play a significant role in raising productivity of the agricultural sector by facilitating farmers' access to technically and economically efficient inputs at reduced costs, thereby increasing profitability. Recognizing the role of agriculture in reducing rural poverty and stimulating economic growth, the need to facilitate access to agricultural inputs has long been on the agenda of policy-makers.[2]

1 Agricultural Development Economics Division, (FAO).

2 In this chapter I focus on fertilizer subsidies, although the concept of "input subsidy" can be interpreted more widely. For example, any kind of public investment promoting input use may be considered an input

Since the 1960s, African governments promoted the use of fertilizer through universal subsidies that dominated agricultural policies in sub-Saharan Africa. In addition to providing direct subsidies that reduced the prices of fertilizer below market-level for all producers, the distribution and procurement of fertilizer was controlled and managed centrally. State owned parastatals had a legal monopoly on importing and distributing fertilizer as part of agricultural credit schemes managed by the government. These policies were often implemented through pan-territorial pricing, which supported agriculture in remote and less market-integrated areas.

There was a significant change in ideology in the early 1980s as structural adjustment programmes were initiated. Under the liberalization agenda, universal subsidies came under heavy criticisms by donor institutions who highlighted several negative impacts of these subsidy programmes. It was emphasized that universal subsidies are not compatible with the principles of the free market, they are expensive, involve high implementation and transaction costs and constitute a heavy burden on government budget. In addition, they distort market and farmer incentives, slow down the development of the private sector and, most importantly, benefit wealthier farmers who are not eligible for such transfers. Following these arguments, donors withheld support to input subsidy programmes, subsidies were gradually abolished and government parastatals and institutions were dismantled and privatized. Consequently, the cost of fertilizer rose sharply, restricting access to small-scale farmers. The use of input subsidies was subsequently discouraged for two decades.

Since the mid-1990s there has been a resurgence of interest in agricultural input subsidies owing to several factors. First, the World Bank acknowledged the failure of liberalization policies in supporting agricultural and social development, having "resulted in significant reductions in overall levels of fertilizer use and increased food insecurity among many rural households" (Morris et al., 2007, p. 4). Political demands for fertilizer subsidies, stagnation of agriculture for decades, declining soil fertility and deteriorating livelihoods of poor rural households have contributed to a reassessment of policies and several new subsidy programmes have been designed (or expanded) in different countries.[3] Agricultural subsidies are now again considered a potentially useful way of promoting agricultural growth and food security.

Rising prices of food and fertilizer have also contributed to the renewed interest in input subsidies. High food prices have impacted poor rural economies in several ways. The most obvious negative impacts are on poor consumers, who are net food buyers. For them, a rise in staple food prices results in a decline in real income which affects expenditure, consumption and long-term welfare through reduced expenditure on health, nutrition and education. High prices of agricultural inputs reduce the profitability of input use, constrain access to inputs (which can lead to reduced application on staple crops) and result in lower food production and higher food prices. This suggests that in the context of high food and fertilizer prices, the potential benefits of input subsidy programmes increase significantly by addressing the problem of access to agricultural inputs.

The renewed interest in input subsidies, however, does not imply a return to the "old system" of universal subsidies that remain criticized in donor policies. Instead, a new generation of so-called "smart subsidies" has gained importance. The principles underlying "smart" subsidies are designed to address failures of the market, promote market

subsidy including provision of agricultural research, extension services, irrigation pumps, etc. This, however, goes beyond the purpose of this chapter.

3 Countries in Africa include Ghana, Kenya, Mali, Malawi, Nigeria, Rwanda, Senegal and the United Republic of Tanzania.

Table 26.1: Objectives of input subsidy programmes

Purchases through FPF	Recipient country	Prog. category	Country allocation	Price per mt - FPF	Revised price per mt - WCF Facility	Savings \losses	Days saved
Dec-08	Zimbabwe	PRRO	5 200	269.00	279.76	55 952.00	33
Dec-08	Kenya	EMOP	14 646	269.00	279.76	157 590.96	51
Dec-08	DR Congo	PRRO	1 639	269.00	279.76	17 635.64	63
Dec-08	Zimbabwe	PRRO	10 000	274.80	285.79	109 900.00	32
Dec-08	Zimbabwe	PRRO	1 950	274.80	285.79	21 430.50	33
Dec-08	Kenya	EMOP	1 550	274.80	285.79	17 034.50	54
Dec-08	DR Congo	PRRO	9 485	277.00	287.99	104 240.15	65
Dec-08	Kenya	PRRO	5 515	277.00	287.99	60 609.85	53
Dec-08	Zimbabwe	PRRO	3 150	281.00	292.24	35 406.00	34
May-09	Kenya	EMOP	10 000	290.00	275.50	- 145 000.00	61
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May-09	DR Congo	PRRO	1 527	290.00	275.50	- 22 141.50	63
Jul-09	Kenya	PRRO	15 000	199.00	222.80	357 000.00	53
Oct-09	Somalia	EMOP	14 721	212.51	242.26	437 949.75	61
Oct-09	Kenya	PRRO	15 279	212.51	242.26	454 550.25	54
Oct-09	Somalia	EMOP	5 000	398.00	453.72	278 600.00	59
Nov-09	Somalia	EMOP	15 000	234.00	208.26	- 386 100.00	58
Oct-09	Somalia	EMOP	1 000	400.60	456.68	56 080.00	61

development, boost sustainable development of agricultural input markets and enhance the welfare of the poor. Smart subsidies should stimulate demand in private markets through lower prices of inputs and benefit private distributors by facilitating entry into input markets and by helping to achieve economies of scale. Smart subsidies are designed to target the poor and thus favour market-based solutions in input supply and aim to promote pro-poor economic growth through increasing competition, economic efficiency and empowerment of farmers (Morris et al., 2007:103-4).

Objectives, impacts and “dangers” of subsidy programmes

Input subsidy programmes can have a variety of interrelated objectives and can benefit farmers in various ways. When implemented, subsidies will generate various impacts in the economy and will have several secondary spillover effects. The design and implementation of subsidy programmes, however, require special attention, because in addition to positive impacts, subsidies can also do as much harm as good. Below I review the objectives, impacts and the potential “dangers” of input subsidies.

The objectives of input subsidy programmes can be grouped into four categories including agricultural policy, economic growth, social protection and political objectives. Programmes often combine several of these, many of which are complementary in most of the cases, but some are mutually exclusive. They serve as criteria against which the programme can be evaluated, while the objectives of the subsidy in turn determine the key design and implementation elements of programmes. The possible objectives of subsidy programmes are summarized in the Table 26.1.

In a recent review of ten subsidy programmes implemented in Africa, Dorward (2009) finds that the three most popular programme objectives include increasing food production (food security objective), adoption of inputs (agricultural policy objective) and welfare of producers (economic objective). While political objectives were involved in large programmes, other objectives were only included in an ad hoc manner. Beside the tendency to focus on production and producer welfare objectives, programmes have tended to ignore the objective of wider pro-poor economic growth. A single programme, however, should not be expected to achieve multiple objectives in a sustainable way; instead, prioritized objectives are needed for input subsidy programmes.[4]

Following the identification of programme objectives, the possible impacts of policies should be considered. The various impacts are interrelated.

Impact on input prices: Input subsidies, by definition, lower the prices of agricultural inputs. The subsidy reduces costs to farmers and indirectly increases income of poor farmers and consumers, while the policy is financed by less poor farmers and taxpayers. Owing to the income transfer, farmers can increase the use of inputs which in turn contributes towards increased output.[5]

Impact on production and prices of staple crop: Input subsidies replenish soil fertility and when applied to staple crops they can increase (and stabilize) the level of production at both the household and the national level.[6] Subsidies should encourage the production of those products where there is likely to be a substantial increase in supply and which have inelastic demand among the poor, mainly staple grains. Subsidies thereby have a potential to contribute to wider growth when applied to production of grains. The magnitude of increase in production depends on several factors including quality of the input, timing of delivery, complementary resources such as availability of seed, weather conditions, as well as technical skills of beneficiaries in using the inputs. By increasing output, subsidies can potentially lower the prices of staple food, especially if the country is isolated geographically from the international market and high transport costs cause domestic food prices to be higher than import parity. Increases in production may also shorten and reduce the magnitude of price upswings in the domestic market and thereby contribute to consumers' welfare and increase their real incomes. In order to impact producer prices, programmes should be large enough and be supplemented by complementary investments and policies to develop output markets.[7]

Impact on rural wages: If the subsidy affecting production pushes up demand for agricultural on-farm labour, there will be an increase in rural real incomes, which may benefit even those who are not recipients of the targeted subsidy programme. Increased incomes may further increase the demand for inputs, and the transfer to producers will be passed back to suppliers.

Impact on input market development: Because the policy (ideally) involves the private sector, it has the potential to contribute to the development of the input market in the country by facilitating investment in marketing systems and lowering transaction costs. As the market expands and volumes increase, new suppliers - both subsidized and unsubsidized - will enter business enterprise. Consequently, market margins will decline and competition, efficiency and the potential to realize economies of scale will increase.

Multiplier effects on other markets: By increasing wages and real incomes of staple producers and consumers, subsidies can facilitate a long-term expansion of rural markets by boosting demand for products such as livestock, horticultural crops, non-farm goods as well as services. As productivity increases, land is released and supply capacity can develop. Through such multiplier effects,

[4] It is frequently argued that subsidies are not the best choice for attaining social safety net and poverty reduction objectives owing to the significant opportunity cost of input subsidies at the expense of other public goods, including infrastructure, education or health services.

[5] There are counter-arguments to this. If demand for fertilizer increases (owing to lower costs) prices may be pushed up, further neutralizing the impact of the subsidy (Salzburg, 2008). Thus, it is important that the government ensures the availability of fertilizers in the market.

[6] This argument has been challenged on two grounds. First, the supply response to fertilizer depends on exogenous factors such as rainfall and other risks to production, therefore the increase in supply is not guaranteed. Second, focusing on staple crops may crowd out the production of other crops such as cassava and overall supply in the country may actually decline.

[7] It should be noted that a fall in producer prices may incur loss for less poor producers who normally produce a surplus and sell it. To compensate, alternative activities should be open for them.

subsidies can facilitate changes in livelihoods over the long-run. There can be further spillover effects onto other markets as interlocking arrangements are made among input suppliers and other agents.[8]

Social impact and growth: Input subsidies provide social protection and strengthen food security at the household and at the national level by increasing staple crop production and lowering food prices, especially if the country is not fully integrated with international markets. Lowering food prices can have ambiguous consequences. On the one hand, lower output prices result in declining producer surplus and increasing consumer welfare, which is achieved from the transfer from producers. On the other hand, however, lower prices (and increased production) can lower returns and lead to farmer losses.

The above discussion points to potential impacts and outcomes of subsidy programmes that are difficult to analyse in practice as there is little evidence on them from recently implemented subsidy programmes in Africa (Dorward, 2009). It is challenging to estimate, measure or collect information on the extent to which subsidy programmes have influenced prices of staple foodstuffs, increased demand for labour in rural areas, leaked to non-eligible recipients, replenished soil fertility or whether they have generated economic growth in any respect. The limited attention devoted to estimate leakage and displacement may also be related to political issues.

An input subsidy programme can create large potential benefits if the programme is implemented effectively and efficiently. However, there is also potential for large economic losses and for generating adverse consequences in a free and liberalized market setting. Input subsidies involve high costs, especially during periods characterized by volatile food prices, and huge financial losses can be incurred if the policy is not implemented in the right manner. The potential "dangers" of subsidy programmes include the following:

Market distortions and out private sector investment: Subsidies may undermine the incentives for private investment in the input market if subsidized sales displace unsubsidized commercial sales. A decline in demand for commercial fertilizers can discourage the participation of the private sector. Subsidies may create risks and uncertainty in the market and private enterprises may incur losses.

Subsidy used for political purposes: Rationing and targeting subsidized inputs has a potential to be influenced by political factors. There are potential political interests in expanding subsidy programmes, but the pressure to control or reduce subsidies is usually weak. The subsidy may create opportunities for rent seeking and fraud.

Subsidy not reaching intended beneficiaries - leakage of subsidy: Though the intended beneficiaries of input subsidy programmes are poor farmers, part of the input subsidy may go to producers who would be using fertilizer even without the subsidy. In this case, the subsidy will not deliver additional economic gain as the product would be produced even without the subsidy. Another reason the subsidy may not be reaching the target population is that the poor may not be able to afford the inputs even at subsidized prices.

Subsidy not applied to staple crops: Input subsidies are intended to promote the production of staple crops, but fertilizers can be applied to a variety of crops including higher return cash crops. If fertilizer is not applied on staple crops, the intended outcomes may not be achieved. Higher return cash crops are often produced in large quantities by commercial farms, and therefore diversion away from staple crops towards the production of cash crops also implies that the poor will not benefit from the programme.

Subsidy not used within the country: The input subsidy should be used in the country in which the programme is funded. However, countries in sub-Saharan Africa have porous borders and cross-border leakages may happen if inputs are sold outside the country.

[8] For example, a network selling inputs can also specialize in other products.

Exogenous factors: All of the positive impacts of subsidies depend on exogenous factors including rainfall and soil fertility. Funding fertilizer subsidies is therefore a risky investment.

Complementary measures: The application of fertilizer requires technical knowledge of management practices and the right application methods. If this knowledge is missing in the target population, the impact of the subsidy programme will be significantly reduced. Beneficiaries may overuse inputs owing to easy access or artificially low prices and may not focus on labour-intensive production techniques. Therefore, the subsidy programme should include complementary policies.

High variability of prices: Prices of staple crops may fluctuate significantly, which may discourage investment in input markets. There is a seasonal time lag between fertilizer and staple crop prices as well. As fertilizer is purchased and applied several months before the crop for which it is used is harvested and sold, the economic returns of the input subsidy programme will depend on how input and output (staple crop) prices change during the production cycle.

Based on the above framework, subsidy programmes should achieve their intended objectives, generate positive impacts and minimize the occurrence of potential "dangers" and negative impacts. A good subsidy programme will therefore:

- foster pro-poor economic growth and generate benefits for consumers by increasing the production of staple food;
- lower the prices of staple crops;
- target those producers who cannot afford to access inputs in sufficient quantities in a timely and cost effective way;
- support the development of commercial input markets; and,
- avoid leakages to non-poor households and discourage the development of secondary markets.

To implement smart subsidy programmes attention should be paid to targeting specific household types, determining the level of subsidy (rationing), avoiding negative impacts on the market and on economic growth, timing the programme, harmonizing with other policies and ensuring that adequate amount of inputs are available. These aspects are discussed in detail in the following section.

Implementing "market-smart" input subsidies

Targeting

There are several aspects of targeting input subsidies that must be considered when implementing the programme:

- The first question relates to the objectives of the subsidy: what is it that the subsidy programme is trying to achieve and, specifically, which crop(s) should the policy target in order to achieve its goals?
- The second question then follows, who should benefit from the programme: what categories of farmers (or institutions) should be targeted?
- Third, what are the possible targeting methods to reach these potential beneficiaries?
- Finally, how can targeting be improved and what are the potential "mistakes"?

Below I revisit these questions in the respective order.

As demonstrated earlier, recently implemented "smart subsidy" programmes, at least in Africa, have aimed to increase food security, welfare of the poor and agricultural production in the country. In order to achieve these goals, inputs should be applied on those products that have the potential to stimulate a substantial increase in food supply. Smart input subsidies should therefore encourage the production of staple food crops.

If the policy aims to increase the *food* supply, then input subsidies should be delivered to producers whose usage of input has been constrained by market failures. The subsidy programme should therefore target:

- those farmers who would either not use inputs in the absence of the subsidy (or use very little); or,
- who are likely to use substantially more inputs as a result of the subsidy.

There will be no economic gain if the subsidy benefits farmers who would purchase the inputs anyway, even without the subsidy. The primary, and generally only, focus of smart subsidies are resource-constrained but productive farmers who cultivate staple crops.[9] There are at least two powerful arguments to target the poorest among these farmers in order to facilitate incremental use of inputs by those who would otherwise not use those inputs. First, poorer farms are thought to be generally more efficient in cultivating labour-intensive *staple food* crops, while larger farms tend to be more efficient in producing capital-intensive higher value cash crops. If the aim of the programme is to promote staple crop production, increase welfare, reduce displacement and address market failures, then targeting the poor will deliver wider benefits. Second, there is no clear evidence of a relationship between farm size and efficiency (Dorward, 2009).[10] This constitutes a counter-argument that the poor usually make less efficient use of inputs and therefore the overall impact of the subsidy would be higher if it targets the less poor.

The most frequently used methods to target poor resource-constrained farmers have combined *geographical targeting* with *intra-community targeting* and *self-targeting*.[11] The assumption is that in remote regions fertilizer use remains lower because inputs cost more owing to higher cost of transport, while farm gate prices of staple crops are often lower than in other areas, for the same reasons. Input subsidies can be provided unconditionally using poverty criteria. Community-based targeting (intra-community targeting) has been the most widely used method. It is often difficult to ensure with this targeting method that the poor benefit from the transfer: an evaluation of the Targeted Input Programme in Malawi, for example, did not find evidence that beneficiaries would be poorer than non-beneficiaries. For this reason it is often recommended to introduce self-targeting, for example, by linking public works programmes with the distribution of inputs as better off farmers are less likely to participate in such programmes.

Another aspect of targeting is to find ways to get the inputs to farmers. It is often argued that the best means to deliver smart subsidies is through *input vouchers*.[12] Vouchers have been used extensively in recent years and are certainly more efficient than direct distribution of fertilizer. The voucher system functions in the following way: farmers receive vouchers which they take to suppliers to exchange for inputs (fertilizer, seed or pesticides) and the supplier gets reimbursed (sometimes including a handling fee) for the value of the coupon

[9] A subsidy can also be provided to input suppliers. In India, for example, fertilizer subsidies have been given to domestic producers to develop the local market and the fertilizer industry (Dorward, 2009). Given that only few African countries produce fertilizer, I do not discuss this option further.

[10] Recently implemented subsidy programmes in Africa widely differ in targeting. Some have focussed on the poorest (food insecure and vulnerable) households, but others have targeted the less poor, better-off, households in order to maximize production.

[11] For a detailed review of methods, costs and modes of implementation of targeting, refer to Chapter 24.

[12] Other instruments used to target smart subsidies include matching grants to producer organizations (used for example in Mali and Nigeria) and partial loan guarantees to support the establishment of an input dealer system (Malawi and Kenya). Direct distributions implemented by government institutions or input suppliers can be more controversial and general price support is not considered a "smart" subsidy. In the following I focus on vouchers as the most widely-used means to target smart subsidies.

by a bank or a designated agency. The voucher system satisfies the requirements of smart subsidies in that it uses private sector suppliers for targeting. This system stimulates the development of the private-sector input market as suppliers get a guaranteed demand and profit margin for their supply, which reduces risks and uncertainties in their business.

The voucher system has several advantages over other methods for transferring the benefits of the programme. In addition to supporting the private sector, and hence being market-smart, the voucher itself is a flexible asset which can be converted or modified. It is possible to convert the voucher into another type of subsidy (for example to a production credit which can be repaid at harvest time) or reduce the value of the voucher to facilitate exit from the programme, which is often a major dilemma in subsidy programmes. On the other hand, vouchers can be criticized for incurring relatively high administrative costs (printing, management, targeting smallholders). The opportunity cost of using vouchers may therefore be relatively high compared with investments into infrastructure, education or health.

Based on the discussion above, several recommendations can be made to increase the efficiency of targeting and reduce leakage of input subsidies. They include the following:

Discourage the sale of subsidized input by recipients: The subsidized input should be kept and used by those poor beneficiaries who were initially targeted. If they sell the inputs instead of applying them on their own crops, it will end up benefiting better-off farmers. As larger farms often produce higher value cash crops, staple food production may not increase at the national level to the same extent, and there will be no reduction in output prices that would benefit poor net food buyers. At the same time, the subsidy will not increase food entitlements (through increased production) of poor households.

Ensure that input suppliers are situated locally: If farmers are targeted through vouchers, the costs of exchanging vouchers for inputs can increase significantly if there are no input suppliers situated locally. The areas targeted by vouchers should have sufficient amount of suppliers who will exchange the voucher for inputs.

Ensure that the type of fertilizer " matches " the crop: Certain crops are responsive to certain types of fertilizers. The type of fertilizer which is supported by the system should be 'compatible' with the crop which is targeted by the subsidy.

Try to make the system competitive: In order to facilitate the development of the input market, vouchers should be redeemable at private input suppliers. Using several private dealers as suppliers of fertilizer, instead of relying only on the government or on a few selected private entities, will make a significant contribution to the development of the private distribution network.

Sustain the system over time and stay consistent: Once a voucher system has been developed, try to keep it functional in a consistent manner for at least five years. This will allow sufficient time to develop the system further, boost the development of the private market and increase efficiency of fertilizer use by farmers. It is often challenging to sustain programmes for longer periods owing to shorter funding cycles of donors and government, but every effort should be made to make the programme sustainable, especially if it has achieved significant gains.

Identify intended beneficiaries clearly and introduce control systems: The programme should identify clear criteria to target beneficiaries and should include mechanisms to control and verify the efficiency of targeting. For example, land size is one such aspect that has been used in recent subsidy programmes.

Increase targeting efficiency by limiting ration size: It has been found in some subsidy programmes that an effective way to increase the efficiency of targeting is to limit the quantity of subsidized inputs to a level that is too small to interest better-off farmers but sufficiently large to benefit poorer producers. This means essentially introducing a self-targeting element in the programme.

Minimize political interference in the programme: Despite the importance of keeping the subsidy programme apolitical, this may be challenging to achieve, especially during elections.

However well targeting is managed, it will never be perfect and there will always be inclusion and exclusion errors. The final distribution of the subsidy and the effectiveness of targeting will be influenced by social, cultural and political factors and formal targeting criteria (geographical and intra-community targeting) will differ from the de facto criteria which is actually implemented. In the case of input subsidies, however, contrary to other types of social protection measures, mis-targeting may be less of a problem for several reasons.

- First, if there is leakage of inputs to non-poor producers, poor net-food-buyers may still benefit from the programme if it results in decreasing staple food prices.[13]
- Second, even if recipients resell vouchers on the market, the targeted group still benefits from the cash income. Therefore, as long as poor farmers receive the vouchers initially, the existence of a secondary market does not necessarily indicate that targeting has failed.

The latter argument implies that targeting matters in input subsidy programmes only if the programme has social objectives, such as enhancing household food security or reducing poverty.

Rationing, cost and availability of inputs

The subsidy is an income transfer to the farmer through which the cost of the input is reduced by the value of the transfer. Under a free market setting with no subsidies, the price of the input would be the import parity price, while the level of the subsidy would be the difference between the import parity price and what the participant farmer actually pays. There are several methods to determine the appropriate level of the subsidy, both at the micro and at the macro level.

At the micro (household) level, the general rule is that the subsidy should bring fertilizer prices down to an affordable level for low-income poorer farmers. The right level of subsidy can be estimated both in absolute and relative terms.

- Integrated household surveys usually provide representative data on the average income of the poor and the ultra-poor and the level of the subsidy which is required to compensate beneficiaries can be calculated from the difference between the import parity prices of fertilizer and the average income level of the poor. In other words, this method indicates the rate at which the target population can afford the input.
- Another possible benchmark in determining the level of subsidy is to compare the cost of inputs with the prices of food. The subsidy should increase the profitability of poor farmers' agricultural production to the level that it offsets the decline in income that is generated by the higher costs of inputs. The prices of food (output) will indicate this level.

At the macro level, the total cost of the programme is determined by the number of farmers who benefit from the programme and by the level of subsidy per beneficiary. The following points should be taken into account when determining the total cost of the programme.

- The basic condition for the subsidy is that the value of the additional output generated should be higher than the overall cost of the input distributed to and used by farmers, including administration costs. A programme should achieve this goal in order to create a positive economic return at the macro level and to be cost-effective.
- The total cost of implementing the input programme, in addition to budgetary costs, includes various opportunity costs. It is important to take into account the potential benefits that may be achieved if the resources used in the subsidy programme were channelled into alternative

13 On the other hand, net sellers will lose in cases of lower product prices, but the poor are usually net buyers of food.

policy instruments, such as investments into public goods with productive value or various social programmes. It may be challenging to calculate because the subsidy programme, as discussed earlier, can potentially generate wider impacts through multipliers and the total benefit that it can generate is, therefore, not constrained to income transfer to producers.[14]

The amount of the subsidy should neither be too low nor too high. If the level of transfer is set too high, the influence of political factors will increase over economic considerations and so will the possibility of large farms benefiting from the programme. In general, larger programmes are more difficult to manage and their higher budgetary costs are difficult to control. They also have the potential to crowd out complementary investments. On the other hand, small programmes are unlikely to be able to achieve economy-wide impacts and foster market development.

During the 2007-08 price swing, the world prices of food, fertilizer as well as ocean freight and transport costs all increased substantially. This reduced the potential returns to input subsidy programmes and increased the burden on national budgets. Nevertheless, the majority of subsidy programmes recently implemented in Africa have been quite significant and have subsidized input prices by at least 50 percent in order to make inputs affordable for producers (Dorward, 2009).

Finally, financial support for fertilizer subsidy programmes can be obtained from various sources including government, donors and aid agencies. In Malawi, for example, input subsidy programmes were initially funded by donors, but recently donor funding stopped and the government took over financing the programme.

Avoid harming the private sector

Fertilizer is imported in most countries of sub-Saharan Africa, often by private companies, and markets are usually small and geographically dispersed. These markets are therefore sensitive to drastic interventions. The effects of the subsidy on the input market will depend on several factors including the nature of the subsidy, the structure of the input supply system, and the scale of the subsidy programme. Only if the subsidy programme is implemented on a sufficiently large scale will there be impact on output prices and markets.

As discussed earlier, subsidy programmes can harm the private sector in many ways. However, recent subsidy programmes in Africa have mainly used private companies to provide fertilizer. In order to avoid negative effects, smart subsidy programmes should operate along the following lines.

Avoid creating risk and uncertainty in the market: Market development requires clear and stable policies that should be sustained over time. Aim to achieve long-term structural changes instead of implementing short-term and ad hoc policies with unexpected changes.

Develop trust between the private and public sector and set clear rules on government contracts: As private companies participate in the subsidy system, they will develop an interest to benefit from government contracts to provide subsidized inputs. As a result, their incentives may change from expanding profitable sales on the market towards dependency on government contracts. The conditions for companies to benefit from such contracts should be clear and transparent.

Keep market opportunities open for potential new suppliers: As the market expands with increased volumes, new suppliers of inputs will express interest in joining the programme. If they are left out from the programme they may shortly go out of business. Their participation and entry to the market should be encouraged and facilitated in order to increase competition and realize economies of scale.

[14] In fact, input subsidies are less efficient in delivering income transfers owing to high administration costs and because of the need for complementary services.

Encourage the evolution of spillover effects in related markets: Interlocking arrangements will gradually develop among input suppliers and other agents in the market. This is a positive sign of market expansion which needs to be encouraged.

Promote efficiency: Make sure that subsidized sales do not displace existing commercial (unsubsidized) sales or private sector dealers.

Timing of delivery

As agricultural inputs are linked to agricultural production cycle (rains), timing is of particular importance for the success of the programme. The subsidy programme should be implemented well before the time inputs are applied to field crops. If the programme is implemented too late, the entire basis for investment may be lost. Late delivery of inputs owing to delays in decision-making and budgeting has been a frequent problem in recent input subsidy programmes in sub-Saharan Africa.

It is frequently argued that subsidies "cannot go on forever" and should eventually be phased out. There are at least three reasons for this.

- The first argument is that with increased volumes, market prices of fertilizer will eventually fall to the "true economic prices" and the need for subsidies will disappear.[15]
- Second, with time the market infrastructure will develop and markets will be functioning efficiently and subsidies will no longer be needed.
- Third, the risks and potential "dangers" of subsidies such as diversion of resources and political influence will increase over time, therefore programmes should not be maintained for too long.

These arguments contradict our recommendations that the subsidy system should be sustained in a consistent manner in order to build capacity and knowledge over time. While it is true that sustained and repeated interventions may distort the market, targeted "smart" subsidies, if well implemented, can indeed be maintained and improved over time with constant revision and monitoring of impact. Well-managed smart subsidies will not influence "true" prices and if sufficient control is introduced in the system, leakage and political influence will not divert resources from intended beneficiaries.

Harmonization with other complementary policies

The input subsidy programme is part of a holistic agricultural policy that pursues several other aims in the agricultural sector. These complementary policies include, among others, the provision of extension services (e.g. information to farmers on soil management techniques), financial services to farmers such as credit and price insurance, stabilization of food prices, supply of complementary inputs, supporting intermediate actors in the input market and the development of market infrastructure.

While the implementation of the subsidy programme should be harmonized with complementary programmes, an important question is the balance between them. If the aim is to maximize returns from agricultural development, food security and poverty reduction policies, what proportion of the total expenditure should be spent on input subsidies and what proportion on other investments? In other words, in order to improve access to fertilizer over the long-run, should targeted input subsidies be used or would other policies achieve better results?

[15] This argument raises some compelling questions. First, is there a "true" price for fertilizer if rural markets are so unintegrated? Second, how long would it take to develop markets to the level that they indeed become competitive? And third, how sustainable would this market be with fluctuating food and fertilizer prices?

Table 26.2: Evaluation indicators of input subsidy programmes

Impact on	Criteria
Programme characteristics	Timing
	Monitoring of performance
	Cost-benefit analysis
Economic impact	Changes in prices of output
	Changes in prices of input
	Impact on labour market
	Impact on growth and consumer welfare
Production	Increase in production
	Increase in productivity
	Replenishing soil fertility
Input market	Leakage of subsidy
	Displacement of commercial sales – impact on markets
	Increase in input use

The answer to this question depends on the functioning and development of other sectors in the economy which are context-specific. If, for example, farmers have reasonable knowledge about farm management, less investment is needed in extension services, but more is needed in other areas. There is also a geographical dimension to this question. In areas where markets are better developed and function well (for example near tarmac roads and trading centres), less investment may be needed in developing market infrastructure. However, in more remote rural areas greater achievement can be made by investing into development of road networks, communication services to facilitate market development or improving agricultural technologies.

Evaluation of subsidy programmes

Whether or not the subsidy programme has achieved its goals depends on the programme's initial objectives and justifications. Impact indicators can be grouped into four categories including programme characteristics, impact on economic development, impact on production and impact on the input market. Table 26.2 summarizes the various indicators that can be used to evaluate input subsidy programmes.

There are no clear-cut benchmarks with which the individual criteria can be confronted in order to decide whether the programme has achieved its objectives. Table 26.2 includes a list of indicators that can be compared across different programmes or within the same programme over time in order to monitor impact and development.

Conclusion

This chapter has demonstrated that the implementation of input subsidies is a rather complex exercise that involves targeting, rationing, timing, harmonization and complex methods of evaluation. Several methods have been reviewed and some of the "do's and don'ts" of implementation have been discussed.

The real complexity in implementing input subsidy programmes arises from the fact that smart subsidies have multiple objectives that interlink in various ways. There has been little experience with these kinds of programmes to date that would allow a comprehensive evaluation of the various methods. Methodological challenges hamper the analysis of potential impacts and it is difficult to estimate *ex ante* what the likely impact will be on different sectors of the economy.

The importance of political factors should be emphasized separately. Large-scale subsidy programmes can be heavily influenced by political interests and be used for such purposes, not only because they provide subsidized resources, but more importantly because they support the production of staple food crops which have a low elasticity of demand and are vital for the survival of millions of poor farmers around the world. The impact of a carefully designed and well implemented subsidy programme can be distorted by political factors. Chinsinga (2007) summarizes this argument succinctly: "No matter what the technical arguments for or against particular policy positions are, it is ultimately the configuration of political interests that determine policy outcomes on the ground" (Chinsinga, 2007).

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Chapter 27

Investing towards a world free of hunger: lowering vulnerability and enhancing resilience

Josef Schmidhuber and Jelle Bruinsma[1]

Why invest in agriculture?

The need for increased investment in agriculture is a recurring argument throughout this volume. The underlying premise is that investment has the power to reduce poverty and hunger, the twin causes of vulnerability. Around 75 percent of the world's poor live in rural areas. Many directly depend on agriculture or draw a large share of their incomes from agriculture-related activities. Others work as small entrepreneurs in the agriculture-related processing, machinery, storage, seed, feedstuffs or fertilizer sectors. While so many poor and hungry depend on agriculture for their livelihoods, a profound and prolonged lack of investment in agriculture has held back the overall productivity of the sector, sometimes so much that it has lost its function as a viable base for poverty reduction. Importantly, lack of investment has also reduced the ability of farmers to cope with price volatility and exogenous shocks, both weather-related and economic ones.

But there is also ample evidence that this lack of investment can be addressed successfully and that investments can have a massive effect in reducing poverty. Econometric analysis presented in the World Development Report 2008 (World Bank, 2008), for instance, suggests that Gross Domestic Product (GDP) growth arising from agriculture is almost four times as effective in reducing poverty as GDP originating outside the sector. As a labour-intensive sector, agriculture can absorb underused labour, such as landless rural workers and farmers who own too little to make a living. Moreover, agricultural growth reduces food prices and acts as a multiplier in local economies, eventually leading to higher rural wages and vibrant rural markets where farmers and workers spend their earnings.

This chapter updates and expands the FAO Anti-Hunger Programme of 2003 (FAO, 2003). It assesses the investment needs, identifies the instruments and sketches out financing possibilities in agriculture to reach a world free of hunger by 2025. Why 2025? By setting an annual target, we cast a feasible trajectory for the necessary action. The rationale that has motivated this assessment is manifold. First, actual trends to halve hunger by 2015 are drifting away from the stated goals at a worrisome pace. In 2007 and 2008, high and volatile

[1] Josef Schmidhuber, Statistics Division (FAO) and Jelle Bruinsma, Economic and Statistics Department (FAO). The authors express their sincere thanks to FAO colleagues for direct assistance and time for discussions. A particular thanks goes to Elcio Guimaraes for the preparation of Table 27.10.

food prices lifted hunger by 75 million people and the 2009 a global economic crisis pushed the overall total above the mark of 1 billion (FAO, 2009). The chances to reach the 2015 goals have become slim. Second, it cannot suffice - and it is even morally questionable - to aim for merely halving hunger; the ultimate goal must be a world that is completely free from the scourge of chronic undernourishment.

Despite these setbacks, there are encouraging signs that the fight against hunger is receiving new attention. In 2001, Brazil launched a zero hunger programme and in 2006, 27 Latin American countries joined and committed themselves to reaching the same goal by 2025 (FAO, 2006). Developed countries alike have recognized the importance and urgency to resume the fight against hunger. They committed USD 20 billion to improved food security at the G-8 summit in L'Aquila in July 2009 and have put agriculture at centre stage in living up to their commitments. Sketching out how a world free of hunger can be reached by 2025, how agriculture can help accomplish this goal and what sources of finance can be tapped is at the heart of this assessment.

The 2003 Anti-Hunger Programme (AHP) covered the "incremental annual public investment needed to meet the WFS goal"[2] in five broad investment areas, namely: improvements of agricultural productivity, development and conservation of natural resources, expansion of rural infrastructure and market access, strengthening of the capacity for knowledge generation and dissemination and ensuring access to food for the most needy.

The analysis that follows quantifies the additional investment needs (in terms of incremental public investment in agriculture and related supporting areas including complementary policy measures) required to eliminate hunger by 2025. The proposed actions fall into two broad categories. The first comprises a set of investment proposals for agriculture and rural areas designed to create new income opportunities for the rural poor and thus afford more people access to food in a sustainable manner. These measures include investments in rural infrastructure and institutions, research, development and extension as well as natural resource conservation. The second set of measures focuses on direct assistance and includes productive safety nets for poor farmers as well as food safety nets for rural and urban people without access to productive assets. The natural corollary of an integrated programme of investment and built-in safety nets is improving the resilience of those most at risk to economic shocks and climatic disturbances, especially those that cause irreversible damage to human capital and social systems.

The proposal in a nutshell

The overall envelope we propose amounts to an annual total of USD 50.2 billion (Table 27.1). This overall amount would be allocated to five broad categories: rural infrastructure and markets (USD 18.5 billion), natural resource conservation (USD 9.4 billion), research and development (R&D) and extension (USD 6.3 billion) and building rural institutions (USD 5.6 billion). Investments in agriculture and rural areas would be supplemented by expenditures in two safety net programmes: food safety nets with an annual volume of USD 7.5 (food and cash for the most needy) and productive safety nets (provision of basic inputs for small farmers to resume or intensify farming) with annual expenditures of USD 2.9 billion.

2 The 1996 World Food Summit (WFS) target aims at halving the number of undernourished people by 2015 (from its base level in 1990/92).

Table 27.1: Incremental annual public investment needed to eradicate hunger by 2005

Priority area for investment	Estimated annual cost* (USD billions)
1. Expand rural infrastructure and market access	18.5
2. Develop and conserve natural resources	9.4
3. Research, development and extension	6.3
4. Rural institutions	5.6
5. Expenditures for safety nets	
Productive farm safety nets	2.9
Food safety nets	7.5
Total investments and safety net expenditures	50.2

*All costs in 2009 prices.
Source: Authors.

Investments by region

A breakdown of the overall total by region provides a highly differentiated picture. One obvious result is that the largest shares of the proposed programme would be allocated to sub-Saharan Africa and South Asia. Together the two regions account for more than USD 30.9 billion, which is 62 percent of overall programme and 71 percent of the safety net measures.

For sub-Saharan Africa, the high investment requirements reflect the considerable catch-up needed between the baseline outcome and a zero hunger scenario. These baseline projections (see Schmidhuber et al., 2009) suggest that sub-Saharan Africa would account for only a small share of total future investment flows (10 percent of the total), reflecting the region's generally labour-intensive, capital-saving forms of production. It is important to recall that (i) these projections include a large amount of private flows and (ii) they assume that no extra effort will be made towards reducing hunger faster or eliminate it completely. The stubbornly high prevalence of hunger has been a consequence of slow growth in investment in sub-Saharan Africa. Because of the high prevalence of undernourishment (now and in 2025 under the base line projection), it is not surprising that sub-Saharan Africa is expected to require a high amount of public investments to make more and faster progress towards a zero hunger environment.

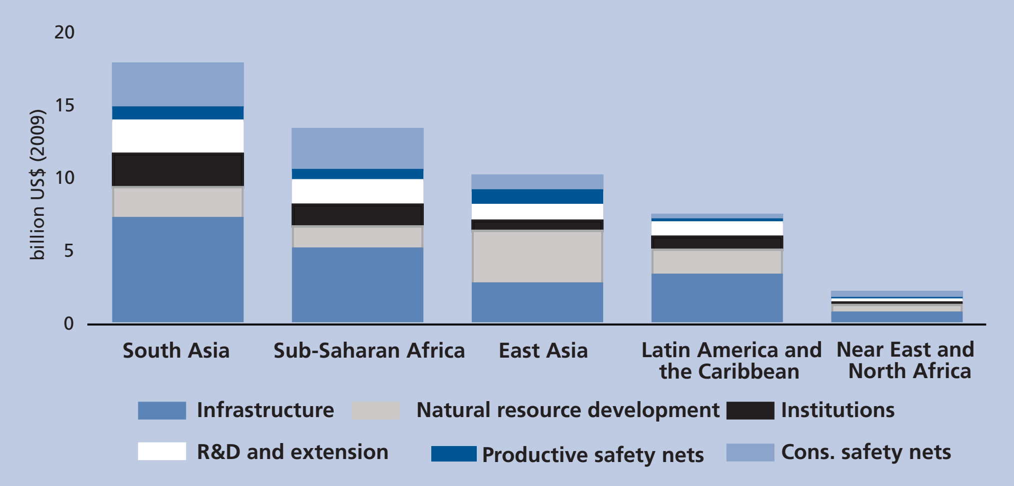
Only South Asia with its large agriculture base and still larger population would need more public investments to reach a zero hunger outcome by 2025. South Asia and sub-Saharan Africa together would absorb more than 60 percent of the incremental public investment needs; investment in rural infrastructure would alone absorb nearly 40 percent of the needs in both regions (Figure 27.1). Both regions would also require high investments in their woefully inadequate storage facilities.

Investing in people

While technically less straightforward than the breakdowns by sector or region, fund allocation by type of asset is equally interesting. To keep matters simple, suffice it to distinguish between investments in people and investments in physical assets.

A fundamental challenge for any investment in poverty reduction is the fact that the poor, the very target of such programmes, hold too few or no physical assets in which to

Figure 27.1: Allocation of funds by region



Source: Authors.

invest. After all, that's why they are poor. Pro-poor growth programmes must therefore not rely exclusively on investments in physical assets, they should also include people and in particular women, promoting their skills, their empowerment and thus their ability to share in the benefits from investments in physical assets. Investing in human capital was an important element of this proposed programme from the outset. The programme allocates over USD 17 billion - or one-third of the overall envelope - to investments in people, including investments in and expenditures for food safety nets, extensions and institutions. In addition, poor people stand to benefit indirectly from jobs created in rural areas (e.g. from the construction and maintenance of infrastructure, storage or processing facilities) even if they own no physical assets.

Investing in productivity and sustainability

In addition, the proposed programme can be broken down by investments in output quantity versus quality of, or differently put, in productivity-enhancing measures and sustainability-promoting ones.

For hunger and poverty reduction to be sustainable, investments must focus on sustainable production methods. The proposed programme addresses this through various efforts. Investments in infrastructure (rural roads, storage) will help reduce losses, improve quality and lift prices received by farmers. They thus help producers generate more income with fewer inputs. A rough estimate suggests that about USD 12.4 billion of the overall investment envelope will either directly or indirectly help reduce losses or improve input use efficiency. Second, the programme directly promotes the adoption of more sustainable production methods. Proposed measures include payments to shift to no-till/conservation agriculture, integrated pest management, or integrated plant nutrition systems. About USD 3.6 billion are earmarked for the adoption of more sustainable production methods. And finally, the programme invests in skills and know-how, which make farmers more efficient in using their inputs and more knowledgeable about the long-term costs they face by pursuing unsustainable production methods. While the effects of improved skills affect many aspects and may have only indirect effects, it is worth noting that about USD 4.1 billion have been allocated to this end.

The benefits

The basic idea of this investment proposal is to create sustainable income-generating activities, numerous and significant enough to generate the purchasing power required for the poor to escape hunger, thereby instilling resilience to weather and economic-induced shocks. These income-generating effects arise in five principal areas. The first stems from higher output of food and fibre and thus higher overall farm revenues. Measured in terms of Gross Value Production (GVP) of agriculture, the expected increase in output would amount to nearly 5 percent by 2025. The increase is derived from the required growth in agricultural output to produce the food and fibre for a global zero hunger outcome by 2025. It is a relatively small amount compared to the overall income effect, and underlines that hunger is above all a poverty problem rather than one of producing enough food. Second, greater benefits can result from all investments that lower input costs and ensure their timely availability, help reduce losses or allow farmers to fetch higher farmgate prices. A third source of income arises from the employment opportunities created in the upstream and downstream sectors, in building and maintaining rural roads, electricity grids or storage facilities. Fourth, a better nutritional status would help break the vicious cycle of mutually reinforcing hunger and poverty.

Hunger perpetuates itself when undernourished mothers give birth to smaller babies who start life with a handicap. Breaking this cycle would unleash enormous productivity potential. Estimates undertaken in the context of the 2003 Anti Hunger Programme (AHP) suggest that every dollar invested in hunger and poverty alleviation would render more than five dollars of benefits as a result of longer and healthier lives for all those who gain from such improvements. The underlying cost benefit calculations in this programme suggest that the benefits are as big as six to one for every dollar invested. Finally, there are difficult-to-quantify but nonetheless important public goods and benefits to be gained. These come from a more efficient use of inputs (e.g. fertilizer or pesticides through Integrated Plant Nutrition Development Systems, IPNS, or Integrated Pest Management, IPM, shallower carbon footprints of agricultural production (e.g. through the adoption of no-till/conservation agriculture), reduced pressure on forests, swampland and other valuable habitats (e.g. through higher land productivity), as well as the broader societal benefits associated with a shift to more sustainable production methods, better flood control, soil conservation, fewer land conflicts or improved biodiversity.

The approach

Setting and defining the goal: what is zero-hunger and how can it be reached?

For practical purposes the assumption is made that a country has reached a state of "zero hunger" when less than 3 percent of its population are chronically undernourished. A further reduction of undernourishment below this level is difficult to achieve and is often a matter of focusing more on empowering people or providing improved health care systems rather than promoting agricultural development. Even in developed countries, pockets of poverty and undernourishment exist amid affluence and advanced social security systems.

Table 27.2: Investment measures by investment area and region (million US Dollars)

	Developing countries	sub-Saharan Africa	Near East and North Africa	Latin America and the Carib-bean	South Asia	East Asia
Infrastructure	**18 540**	**5 024**	**629**	**3 248**	**7 062**	**2 577**
Rural roads	8 194	2 409	244	1 808	2 710	1 022
Markets storage processing (incl. PHL)	5 681	1 282	239	487	2 724	948
Food safety and quality	568	128	24	49	272	95
Rural electrification	4 097	1 205	122	904	1 355	511
Natural resource development	**9 434**	**1 522**	**479**	**1 716**	**2 126**	**3 590**
Land resources	1 396	324	14	83	300	674
Water and irrigation	2 178	263	262	57	1 334	262
Plant genetic resources	600	57	49	92	111	292
Animal genetic resources	460	26	37	112	84	201
Fisheries	2 400	118	56	352	207	1 667
Forestry	2 400	734	61	1 020	90	495
Institutions	**5 568**	**1 492**	**177**	**869**	**2 304**	**726**
Rural finance	3 580	1 032	122	574	1 350	502
Mechanization (cooperatives)	1 192	171	34	147	723	117
Land titling tenure security	796	289	21	148	231	108
Research development and extension	**6 311**	**1 739**	**230**	**1 030**	**2 256**	**1 055**
Research and development	2 180	435	77	343	902	422
Extension	4 132	1 304	154	687	1 354	633
Productive safety nets	**2 875**	**672**	**100**	**187**	**888**	**1 029**
Consumptive safety nets	**7 472**	**2 823**	**374**	**257**	**3 001**	**1 018**
Total	50 199	13 272	1 989	7 307	17 636	9 996

The goal of all measures presented in this programme therefore is to reduce hunger below a prevalence level of 3 percent by 2025. The 2025 reference points for all individual countries are taken from the latest update of the baseline projections[3] for undernourishment. Under these baseline projections, 9.1 percent of the developing countries' population (or 591 million people) would on average still be undernourished by 2025 with a wide variation across countries. Some countries are expected to accomplish zero hunger by 2025 even without further assistance, while others would still be saddled with undernourishment levels of well over 20 percent. A meaningful allocation of investment flows therefore requires a detailed country-specific analysis.

The starting point for this analysis is estimating the extent to which the average dietary energy supply (DES, in kcal per person per day) needs to be raised by 2025. Underlying the needed increase in food availability is the incremental income generated by the investment programme. As rising incomes typically lift consumption at low levels more than at already elevated ones (Engel's law), the average increase in the DES level is associated with a decline in the inequality of the calorie distribution (and thus a declining coefficient of variation, CV). The process of lifting average DES levels is therefore combined with a stepwise lowering of the CVs such that the combined effect of higher DES levels and lower CVs gradually reduced undernourishment to levels under 3 percent by 2025.

The results for undernourishment are summarized in Table 27.3. If all countries achieve the stated objective of "zero hunger", the average level of undernourishment in the developing world would fall to 2.9 percent of the population (or 186 million people) by 2025.

[3] See Alexandratos (2009).

Table 27.3: Base year and 2025 undernourishment

	Population	Under-nourishment*		Population	Undernourishment			
	2003/05			2025	baseline		zero hunger	
	million	*%*	*million*	*million*	*%*	*million*	*%*	*million*
Developing countries	5 020	16.3	821	6 507	9.1	591	2.9	186
sub-Saharan Africa	696	30.4	212	1 130	15.8	179	3.0	34
Near East/North Africa	413	7.9	33	581	5.2	30	2.2	13
Latin America/Caribbean	544	8.3	45	662	5.0	33	2.7	18
South Asia	1 468	21.4	314	1 933	11.5	223	3.0	58
East Asia	1 898	11.4	217	2 202	5.7	127	2.9	64

* for the 93 developing countries covered in this analysis
Source: FAO (2008).

Not surprisingly, the required adjustments both in terms of DES increases and reductions in inequality are the strongest in sub-Saharan Africa and South Asia, the regions most affected by undernourishment today and expected to be under the baseline projections in 2025.

By how much do incomes have to rise?

The basic idea of this investment proposal is to create sustainable income-generating activities numerous and significant enough to generate the purchasing power required for the poor to escape hunger. This poses the question as to how much incomes would have to rise (relative to those assumed in the baseline projections) to provide the necessary increase in purchasing power. Obviously, this increase depends on a number of factors, including the levels of already-attained consumption, the overall level of economic development and the responsiveness of consumers to step up consumption when incomes rise. These factors[4] were combined to calculate the necessary income and investment increases for 93 individual developing countries. Table 27.4 summarizes the results for regional aggregates.

For the developing countries as a whole, the necessary acceleration in growth appears to be rather modest. On average, annual GDP growth would need to increase from 5.4 percent in the baseline compared with 5.7 percent in the zero hunger scenario; this is equivalent to an income level that by 2025 would be 8 percent above the incomes underlying the baseline projections. While the overall growth requirements appear small, growth needs for individual regions (Table 27.4) are much more pronounced. Small increments in growth would suffice for the Near East and North Africa region, East Asia and Latin America, but the growth would need to be much higher in sub-Saharan Africa (±0.7%) and South Asia (±0.9%). Even larger are the growth needs of individual countries in these regions, many which would need to accelerate GDP growth well in excess of 1 percent per annum.

4 Increases in food demand were assumed to depend on per capita income with income elasticities ranging from 0.38 in Latin America and East Asia to 0.58 in sub-Saharan Africa; these elasticities are derived from ICP-based estimates provided by USDA and are available at: http://www.ers.usda.gov/data/internationalfooddemand/

Table 27.4: GDP and investment increases needed to reach zero hunger								
	GDP growth (% p.a.)		Share agriculture in GDP (%)			Annual investments in ARD		Annual increment
	2005-25		2005	2025	2025	billion USD 2009		million USD 2009
	BL*	ZH		BL	ZH	BL	ZH	ZH-BL
Developing countries	5.40	5.72	12.7	6.6	6.4	370	413	42 727
sub-Saharan Africa	4.50	5.22	28.8	19.6	17.8	35	45	10 449
Near East/North Africa	4.09	4.15	12.1	8.2	8.2	49	51	1 615
Latin America/Caribbean	4.44	4.61	7.7	4.5	4.4	46	53	7 050
South Asia	5.41	6.29	18.8	10.0	8.8	82	97	14 636
East Asia	6.38	6.59	11.6	4.9	4.8	158	167	8 978

* BL = baseline. ZH = zero hunger. ARD = Agriculture and Rural Development
Source: Authors.

By how much do investments have to rise?

To achieve such an acceleration in GDP growth, investments would need to be raised on an economy-wide basis. The magnitude of the additional investment needs depends, *inter alia*, on the overall level of development of a particular country and the overall share of investments in GDP.[5] Average annual investments in the developing countries as a share of GDP would need to rise from 19 to 20 percent, again with higher growth in the share for sub-Saharan Africa (from 13.8 to 16.0 percent) and South Asia (from 16.2 to 18.9 percent).

In order to gauge the possible contribution to growth that can be drawn from agriculture, the next step was to determine the share of investments in agriculture relative to total investment, whereby agriculture is defined in the broad sense and includes its upstream and downstream industries. Essential here is to form an idea about how important agriculture is in the total economy and how the share of agricultural GDP (AGDP) in total GDP will evolve over time.[6] Table 27.4 shows that for the developing countries as a whole this share was 12.7 percent in the base year and would decline to 6.6 percent by 2025. Naturally, there is a wide variation in the value of these shares, in general they are high in sub-Saharan Africa and low in Latin America (see Table 27.4).

The required investments in agriculture and its downstream industries were derived by applying (for each year from 2005 to 2025) the share of AGDP in GDP to total economy-wide investments. To reach the stated goal of zero hunger, annual investments in developing countries would need to rise from USD 370 billion to USD 413 billion, an increase of USD 42.7 billion (or almost 12 percent), again with wide variations across regions and even wider

5 This was expressed as an "incremental capital-output ratio" (ICOR) with ICOR values set at three for countries with a per capita income up to USD 2 000, at four for GDP per capita up to USD 4 000 and at five for GDP per capita ≥USD 4 000. For each year from 2005 to 2025, the total investments were calculated as $INVT_T = GDP_T \times ICOR_T \times growthGDP$.

6 Base year shares were taken from the 2008 World Development Indicators and the following function was estimated cross-country over 93 countries: $\ln\left(\frac{AG\_GDP}{GDP}\right) = 6.89 - 0.61 \cdot \ln\left(\frac{GDP}{POP}\right)$. Subsequently this function was calibrated to each country's base year values and then used to estimate the 2025 shares.

variations across countries (Table 27.4). For instance, zero hunger in 2025 would require investments in sub-Saharan Africa to be raised by almost 30 percent.

The overall estimate of USD 42.7 billion requires careful interpretation. First, the incremental annual investment estimate presented here (i.e. USD 42.7 billion) refers to investments needed to raise average per capita income in order to provide the purchasing power needed to buy enough food to reach zero hunger. It does not include "investments" in safety nets to improve the access to food for the poor outside their actual incomes. Expenditures for safety nets are estimated to absorb an additional USD 7.5 billion. Second, the investment estimates refer to agriculture in a broad sense, including its upstream and downstream industries as well as supporting activities in agricultural research and development, extension, rural infrastructure and institutions. Investments in each of these activities will be discussed in more detail below. And finally, the applied approach assumes that investments in the other sectors will increase in parallel to those in agriculture. In other words, acceleration in overall economic development is required to alleviate poverty and to reach zero hunger. The extent to which agriculture can contribute to overall economic growth highly depends on factors such as the strength of forward and backward linkages between agriculture and other sectors, the share of income produced in agriculture and its importance for the overall labour market.

Timing, pacing and sequencing of investment flows

The proposed investment plan presents capital needs in equal instalments over time. Importantly, the plan also advocates that the actual allocations be provided in equal annual amounts. This is not an oversight; nor is it simply a choice of convenience to ease the presentation of the proposal and the underlying data on aid and investment flows. It is rather based on the observation that past crises have resulted in patterns of pro-cyclical public investment flows that have most likely exacerbated or induced price swings. The data presented in Box 27.1 suggest that pro-cyclical timing can be observed both for individual areas of public investment (irrigation, R&D, infrastructure, etc.) as well as for foreign public assistance to agriculture in general.

Investment needs beyond 2025

The current proposal has been designed such that the additional income generated in agriculture and rural areas will suffice to create enough purchasing power so that the vast majority of the rural poor can escape the scourge of hunger by 2025. It is, however, not assumed that the measures taken in the years leading up to 2025 will reach fully self-sustained growth strong enough for the public hand to withdraw completely when the proposed programme reaches its stated objective for the first time. Maintaining the achievements will require continuous commitments beyond the 2025 time horizon.

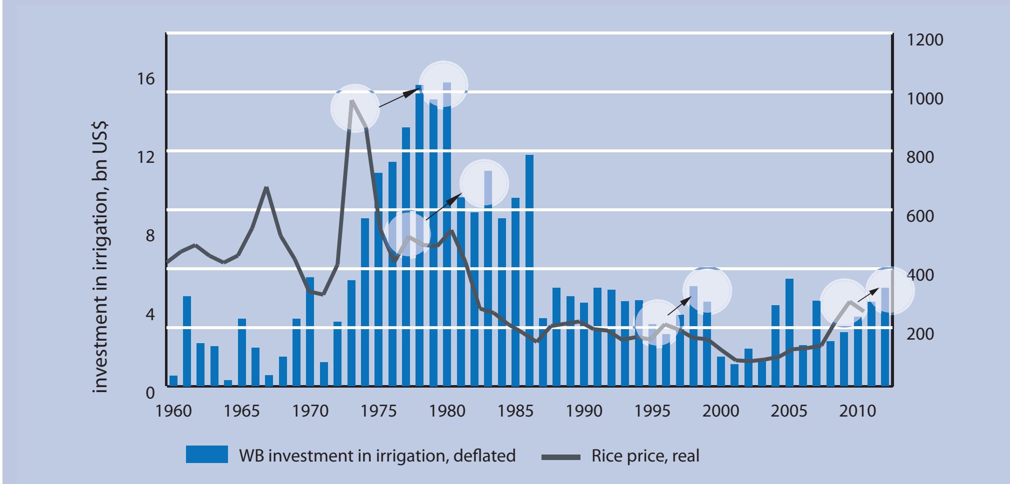
Moreover, a continuously high commitment to provide funding to agriculture and rural areas, extending beyond 2025, will emerge from the need to adapt agriculture to the agro-ecological conditions under climate change. Many countries with a high burden of undernourishment and a high share of agriculture in GDP will be particularly adversely affected and thus require extended assistance to rise to the challenge of climate change.

Box 27.1: Pro-cyclical public investment patterns

The high price event of 2006-08 was not the first of its kind, neither was it the most severe. In real terms, price levels and price volatility were significantly higher in 1973-74 and even more pronounced in the years immediately following World War I (1918-21). Nor was the 1973-74 crisis the most recent episode of price spikes; the last 40 years have seen a number of high price periods (clearly seen in Figure 27.2). Furthermore, the problem of higher price episodes is not limited to rice; in 1996, for instance, annual average maize prices were - in real terms, i.e. adjusted for inflation - above the annual average in 2008, the last record year in terms of nominal prices.

Irrigation and international rice prices

Figure 27.2 World Bank Investment in irrigation (real) and world rice prices (real)

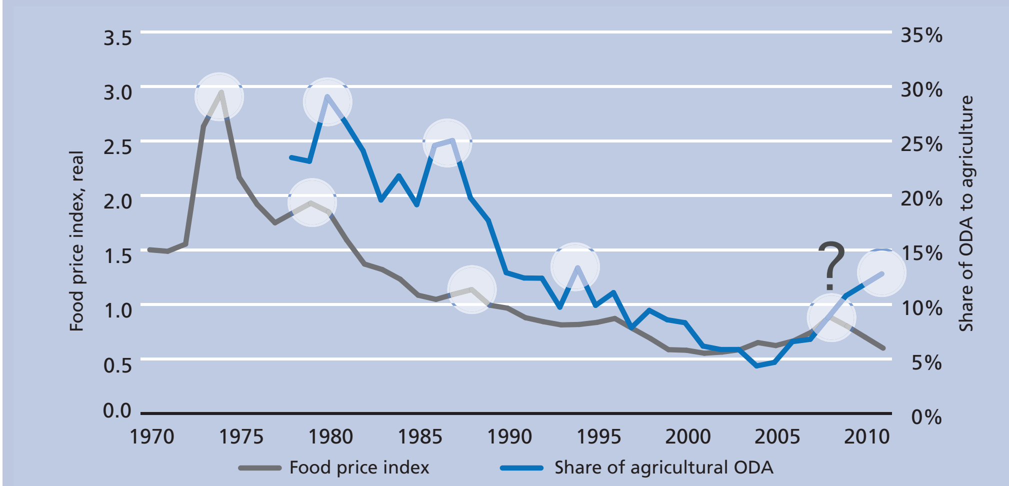


A further inspection of Figure 27.2 reveals more than merely a pronounced cyclicality in international rice prices. It also suggests pro-cyclical public investment flows in response to these price swings. Specifically, it appears that public investments in agriculture follow the general trend but also the swings - with a time lag of three to five years. This means that the public hand invests a lot (little) in production-boosting capital stocks when prices are high (low). By so doing, public investment always arrives at a time when private investors (farmers) have already reacted to price signals and have stepped-up (reduced) commitments to (from) agriculture. This means that the public hand arrives with investments when prices are already low (and thus exacerbate a price trough) and is absent when more output is needed and prices have risen (possibly exacerbating a price peak). Rather than smoothing price swings, public investment thus appears pro-cyclical and increases price swings and volatility. Consequently, public flows: (i) augment the overall risk associated with agricultural production and, rather than crowding in private investors, they crowd them out; and (ii) by augmenting price volatility they lower production relative to a scenario where public investments of the same size are provided in equal instalments.

The problem of pro-cyclical public investment flows should not suggest that the public hand should withdraw from agriculture or related public R&D activities. On the contrary, there is a strong case in favour of public investments in agriculture. Nor does it mean that the public hand should make a particular effort to invest in a counter-cyclical manner. As swings and trends of agricultural prices are impossible to predict, the best approach for the timing and pacing of public investments would be to focus on a long-term development goal (e.g. MDG-1 or the Zero Hunger Goal 2025 put forward here) and then show a firm commitment/steady hand towards reaching that goal regardless of price swings on international food markets.

Agricultural Official Development Assistance (ODA) and food prices in general An inspection of more aggregate data suggests that the problems of pro-cyclical public investment hinders not only individual product areas, but also ODA to agriculture in a more general manner. The basic links are depicted in Figure 27.3. It appears that the share of ODA to agriculture - colloquially put, the barometer of attention in development to food security - follows food prices in a similar way and with similar time lags as illustrated in the case of rice prices and investment in irrigation.

Figure 27.3 Food price index vs share of agricultural ODA



These links can be practically illustrated by summarizing and illuminating the public investment activities that followed the 2008 food price crisis. In reaction to the crisis and to growing public pressure to alleviate food security problems, the international community launched a whole host of activities destined to boost investment in agriculture and increase food production. Without rehashing the details of these programmes, it should suffice here to list the key activities. Examples include the G8 L'Aquila Initiative, the Global Agriculture and Food Security Program (GAFSP) administered by the World Bank, and the World Bank's medium-term plan to double its own commitments to agriculture in a span of the four years following the 2008 crisis. Also worth noting are new commitments to agricultural R&D. The budget for Consultative Group on International Agricultural Research (CGIAR) and its 15 International Research Centers, for instance, is planned to double to nearly USD 1 billion per annum over the next years. In tandem, the internal allocation of funds (Megaprogrammes) will shift back from the original allocation (CGIAR, 2009) towards a production-focused allocation with separate Megaprogrammes for wheat, maize and rice (CGIAR, 2010).

The cyclicality of these efforts is also explained by the fact that the time lags between announced commitments and actual flows can be considerable. Taking the examples above, none of these programmes have rendered flows anywhere near original commitments with the possible exception of the USD 0.9 billion allocated in the GAFSP initiative. The time for decision-making, planning and investment execution of public investors is simply too long, and the international apparatus too slow to invest swiftly enough, i.e. when needs are greatest. These time lags then open the prospect that when and if these programmes come to full fruition, private investors will have already committed to producing more food, the global food security situation may have improved, and public investment will have spurred production in a phase of low prices and structural surpluses. The impossibility to time and pace public investments counter-cyclically has led to the suggestion to allocate the proposed programme in equal installments. This advice may need to be heeded in the allocation of public investment in agriculture more generally.

The programme: investing in safety nets and agricultural productivity

The basic idea of this programme is to create income-generating activities in agriculture and rural areas. The overall envelope required was pegged at an annual total of USD 50.2 billion (see Tables 27.1 and 27.2 for a regional and sectoral breakdown). The overall total would be allocated to five broad categories: rural infrastructure and markets (USD 18.5 billion), natural resource conservation (USD 9.4 billion), research, development and extension (USD 6.3 billion) as well as building rural institutions (USD 5.6 billion). Investments in agriculture and rural areas would be supplemented by expenditures in two safety net programmes: Food safety nets with an annual volume of USD 7.5 (food and cash for the most needy) and productive safety nets (provision of basic inputs for small farmers to resume or intensify farming) with annual expenditures of USD 2.9 billion. Investments in agriculture and rural areas on the one hand and safety nets on the other are the two principal pillars of this programme and correspond to the two tracks of the Anti-Hunger Programme presented in 2003.

Pillar 1: Strengthening safety nets

Food safety nets

A necessary condition for a sustainable, long-term elimination of hunger is the eradication of poverty. But a mere focus on poverty reduction is not always sufficient to address hunger quickly, nor is it always the best strategy to achieve hunger reduction efficiently. The reasons are obvious: first, poverty reduction takes time and the hungry need immediate relief; second, by contrast to many diseases for which cures are either unknown or unaffordable, the means to feed everyone are readily and cheaply available; and third, hunger is as much a cause as an effect of poverty. Unless hunger is reduced, progress in cutting poverty is bound to be slow. Hunger reduction is therefore a means to enhance productivity directly and swiftly. The benefits are equally obvious: better-fed people are more productive workers, better-fed children are more attentive pupils and better fed women are healthier mothers who give birth to healthier children and can feed them better. The proposed programme therefore focuses not only on investments in agriculture and rural areas but also includes measures that ensure adequate and direct access to food. It aims to meet the needs of the most nutritionally deprived people in the world with an overall envelope of USD 7.5 billion annually.

As discussed in Chapter 23, various instruments could be used to channel enough food to the most needy. Proven options include:

- *Targeted direct feeding programmes*. These include school meals, feeding expectant and nursing mothers as well as children under five through primary health centres, soup kitchens and special canteens. Such schemes contribute to human resource development by encouraging children to attend school and improve the health and nutritional status of mothers and infants. They minimize nutrition-related illnesses and mortality among children, raise life expectancy and contribute to a fall in birth rates.
- *Food-for-work programmes*. In many developing countries, a significant number of rural people are subsistence or below-subsistence farmers, producing only enough food to feed their families for part of the year. Food-for-work programmes provide support for such households while developing useful infrastructure such as small-scale irrigation, rural roads and buildings for rural health centres and schools.
- *Income-transfer programmes*. These can be in cash or in kind, including food stamps, subsidized rations and other targeted measures for poor households, and are also a good means of increasing food-purchasing power and improving dietary intake.

Table 27.5: Investment in food safety nets

Region	Baseline	Zero hunger	Increment
	Annual investment		
	million USD		
Developing countries	1 854	9 327	7 472
sub-Saharan Africa	551	3 374	2823
Near East/North Africa	68	442	374
Latin America/Caribbean	94	351	257
South Asia	731	3 732	3 001
East Asia	409	1 428	1 018

The costs of food safety interventions, including procurement, delivery and administrative costs are estimated to be an average of USD 40 per undernourished person leading to a total cost of USD 1.85 billion under the base line projections. This would need to be raised drastically to USD 9.3 billion (or an increase of USD 7.5 billion) to achieve zero hunger by 2025.

Productive safety nets

The need to make progress fast requires taking measures that ensure quick productivity gains for smallholders to raise output. Improving the performance of small farms in poor rural and peri-urban communities offers one of the best and most sustainable avenues for reducing hunger by increasing the quantity and improving the quality of locally available food. It also provides a foundation for equitable economic growth. At the very least, better performance improves food availability and nutrition within the immediate farm families, thereby increasing their capacity to enjoy a full life, learn and work effectively and contribute to the general good of society. It also increases and diversifies food supplies in local markets, creates a base for expanding and diversifying farm output into tradable products, opens employment opportunities and slows rural-urban migration.

The need to produce progress fast explains the massive scale of the proposed programme. Only a large-scale programme can have a meaningful impact on reducing hunger and poverty. Starting up such a process requires an initial injection of capital, either through loans or matching grants, to enable small farmers to build up productive assets on their farms. The average cost of investments required to kick-start a sustainable process of on-farm innovation may be estimated at about USD 600 per family. Typically, this start-up capital would finance the uptake of new technologies, such as improved seed varieties, plants, manure or fertilizers, small-scale on-farm works and equipment (e.g. land levelling, treadle pumps), breeding stock (e.g. poultry, goats) or contributions towards community-led measures to improve food security (e.g. school gardens, paralegal services to broaden land access). To ensure sustainability, farmers who take part in such programmes would repay the initial capital into savings and loans associations or community-run revolving funds, thereby allowing reinvestment of the benefits accruing from higher production.

Success in on-farm development depends on the creation of a policy environment conducive to agricultural growth, supported by research and extension institutions responsive to locally-articulated needs. In many cases, success also depends on developments beyond the farm boundary, such as improvements in roads or in the supply of irrigation water. The investment needs for these improvements are addressed under other programme components.

Sustaining and upscaling this process requires the emergence of self-reliant community institutions that can take the lead in ensuring the food security of all their members, plough gains back into new investments and develop linkages with other communities through sharing knowledge and experience. This enables groups of communities with a common goal to place increasingly effective demand on the broadening range of services and types of infrastructure required to allow them to develop greater resilience to economic, social and natural shocks as well as to earn more and emerge from hunger and extreme poverty. The need to produce progress fast also explains the massive scale of the proposed programme (USD 2.9 billion). Only a large-scale programme can have a meaningful impact on reducing hunger and poverty.

Pillar 2: Investments in agriculture and rural areas

Public research and development (US$ 2.2 billion)

Probably the single most important contribution to the reduction of global hunger in the past has come from early and far-sighted investments in agricultural research and technology. While developed countries had recognized the power of public R&D investments in agriculture for more than a century, the breakthrough in developing countries only arrived with the creation of the CGIAR and its International Agricultural Research Centres (IARCs). Today, the success of these investments has become manifest in many ways. Global agricultural production increased by almost 150 percent since 1961, while over the same period the world's cropland base has increased by merely 14 percent, from 1.4 billion ha to 1.56 billion ha. At the same time, per capita calorie availability in developing countries has increased from 1960 per person per day in 1961/63 to 2620 in 2003/05, while the prevalence of hunger has declined from 34 percent in 1970 to 16 percent in 2003/05. Equally important has been higher productivity, helping raise incomes of millions of farmers and whole rural areas and keeping real food prices low for decades.

Things have changed recently and they have changed abruptly. Food and energy prices spiked in 2006-08 and, directly following this spike, a massive economic downturn that engulfed developed and developing countries alike took a heavy toll on the poor and hungry. Preliminary estimates suggest that the combined effect of higher food prices and economic crisis has pushed the number of undernourished above the one billion mark. The crisis has also affected urban areas, thus underlining that hunger and poverty reduction cannot rely solely on promoting the absorption capacity in manufacturing and services but must begin in agriculture and rural areas. And finally, high energy prices and a growing use of agricultural resources for the energy sector underscores that agriculture may have to cater to more than just the food market in the future. In a future with high energy prices, a growing share of agricultural produce will become competitive for the vast energy market, a market that could absorb much of the incremental agricultural production in the future.

While these developments suggest that research needs have become larger and more complex, investment in public R&D have been levelling-off overall and, in some regions, they have even declined. Since the late 1970s, when most regions still enjoyed high growth rates in R&D investments, expenditures have slowed considerably. For developing countries as a whole, growth in R&D expenditures slowed from three percent *per annum* in the 1980

Table 27.6: Investment in research and development

	Baseline	Zero hunger	Increment
	Annual investment		
	billion USD		*million USD*
Developing countries	42.1	44.2	2 180
sub-Saharan Africa	3.8	4.3	435
Near East/North Africa	3.6	3.7	77
Latin America/Caribbean	7.8	8.1	343
South Asia	7.9	8.8	902
East Asia	18.9	19.3	422

to merely 1.9 percent *per annum* in the 1990s and even less in the 2000s. While expenditure growth remained relatively high in the Asia-Pacific, Near East and North Africa region, public R&D expenditures started to slow already in the 1980s in sub-Saharan Africa and even declined by 0.2 percent per annum in the 1990s. Preliminary estimates suggest that the trend to lower R&D in Africa continued unabated in the 2000s. At the same time, public R&D expenditure has become more concentrated, with China (Mainland), India and Brazil now accounting for 43 percent of this total compared with 35 percent in the early 1980s.

The exact effect of this slow-down in public R&D expenditures is difficult to gauge, but there is ample and cross-sector evidence that it inescapably results in lower productivity growth and eventually in higher real prices for food. Making matters worse recently is that donors have identified more and more goals without raising the overall investment envelope for R&D. This has created increasing and competing demands without increasing the resources. Research for nutritional improvements or environmental benefits for instance have siphoned off funds for productivity improvements. And high yields for wheat and maize in developed countries distracted from badly needed investments in productivity enhancements for many crops in the marginal production environments of developing countries.

Public R&D expenditures therefore must rise again to meet the food and fibre needs of the future. To achieve zero hunger by 2025, developing countries' expenditures will have to rise by USD 2.2 billion annually (Table 27.6). This assumes R&D investment needs of USD 28 to 30 per USD 1 000 increase in value of agricultural output. It does not yet include R&D needs that may arise from climate change adaptation or the potentially huge market for bioenergy. Nor does it include R&D needs to finance maintenance research for the time horizon beyond 2025.

Broken down by region, South Asia would account for over 40 percent of the incremental USD 2.2 billion dollars, reflecting both its large agricultural base as well as the region's high current number of undernourished people. The second highest increment would need to be allocated to sub-Saharan Africa, the region that needs to make the fastest progress in reducing the prevalence of hunger (Table 27.6).

Refocus R&D to the needs of the poor: Two factors are crucial for determining the kind of research needed to achieve the zero hunger goal: (i) it must be targeted to the production environments of the poor; and (ii) it must render results fast. Targeting to the poor means focusing on smallholder agriculture, subsistence and semi-subsistence farms; it implies a particular emphasis on orphan crops, marginal/fragile agro-ecological environments and on a production package that is typically characterized by low capital and high labour intensity. Table 27.7 provides an overview of pro-poor research needs for a wide range of crops, differentiated by biotic and abiotic stress factors.

Re-organize R&D funding and architecture: To avoid under-funding from threatening the survival of existing R&D systems in developing countries, policy-makers must find alternative institutional mechanisms for sustained financing. While some alternative mechanisms have been tried in many countries, the full repertoire of possibilities is far from exhausted. They include joint public-private sector ventures, sale of research products, competitive funds, research foundations, farmer managed levies on production and greater involvement private sector research. Also, universities in developing countries are an underutilized resource that could greatly increase research output with small incremental funding. Research foundations present another alternative to the public sector for providing funding and/or implementing agricultural research. Because the boards of directors of these research foundations usually consist of representatives from the private sector, they often base their research priorities on market demands and therefore provide an important link between the public and private sectors. And finally, while the private sector also offers a considerable potential to boost funding and efficiency of the global agricultural research system, its actual involvement in developing countries' R&D remains fairly small. Ninety-four percent of private sector executed agricultural research is conducted in high-income countries.

The need to deliver fast production increases also means that R&D expenditures cannot be allocated only to science & technology or basic research. The gestation periods of investment in basic research are simply too long to produce substantial results prior to 2025. Instead, the programme requires refocusing overall R&D expenditures from basic research to technology transfer and applied research (e.g. research to turn breeding lines from IARCs into new varieties at the extension and farm level). It also requires much greater expenditures on extension.

Extension (US$ 4.1 billion)

Data on extension expenditures are notoriously difficult to come by and there is no straightforward formula that links needed extension expenditures directly to R&D expenditures or targeted production levels. Experience from individual countries suggests that every dollar spent on R&D should be matched at least by another dollar spent on extension, albeit with large regional differences.

The need to step up production fast in often marginal production environments means that R&D efforts need to be accompanied and indeed preceded by more funds for extension. Long gestation periods between committing R&D funds and practical success on the ground and the quick returns from transferring and adapting existing technologies have motivated the relatively high amounts to be spent on extension. Aggregated over all developing countries, the zero hunger scenario would require about USD 4.1 billion to be allocated to extension services (Table 27.8). Particularly strong is the need in sub-Saharan Africa expenditures where the initial extension expenditures are particularly low and where the catch-up process would be most pronounced.

Table 27.7: Investment in extension			
	Baseline	Zero hunger	Increment
	Annual investment		
	billion USD		*million USD*
Developing countries	74.5	78.7	4 132
sub-Saharan Africa	11.5	12.8	1 304
Near East/North Africa	7.2	7.3	154
Latin America/Caribbean	15.6	16.3	687
South Asia	11.9	13.3	1 354
East Asia	28.4	29.0	633

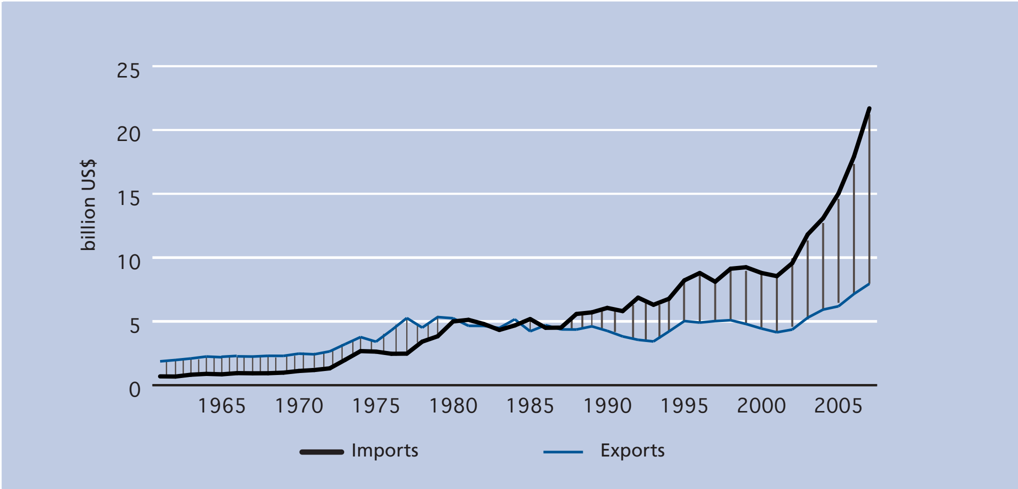
Rural infrastructure (US$ 18.5 billion)

One of the key deficits holding back agricultural development in many developing countries is a profound absence of basic infrastructure. Insufficient transportation systems raise costs for farm inputs and lower farmgate prices for agricultural produce. Insufficient storage exposes farmers to high losses and compromises the quality of their produce. As long as transport is difficult and expensive, electricity unavailable or unreliable and storage inadequate, a productive and profitable agricultural sector remains an elusive goal. Improvements to major infrastructure - particularly rural roads and railways, rural electrification and storage - are therefore the key way out of this impasse. Finding practical means of breaking the infrastructural bottlenecks is therefore a high priority of this programme, and explains the high overall expenditures for infrastructure of USD 18.5 billion annually (Table 27.9).

The USD 18.5 billion comprise a whole range of different investment areas, ranging from rural roads to electrification to cold and dry storage and more. While the estimates for these investment areas will be presented individually, it should be noted from the outset that the various investment areas are highly interdependent and interlinked. Considerable synergies can be had when infrastructure measures are implemented as a comprehensive and consistent package. Investments in cold storage, for instance, require reliable and sufficient rural electrification to be viable. Likewise, investments in milling facilities must be planned with adequate dry storage, electrification and feeder roads. Roads, storage and milling together help establish a processing and transportation chain with minimal losses.

Rural roads (US$ 8.2 billion): The fundamental importance of investing in rural roads lies in its vast potential to reduce transaction costs between farms and urban markets. Rural roads, pathways and, where appropriate, railways lower transportation costs to urban areas and allow farmers to fetch higher farmgate prices for their produce. By shortening transportation time, better rural transportation also helps improve the product quality and reduces losses. At the same time, lower transportation costs reduce prices for inputs, notably fertilizer, feedstuffs, power or pesticides and allow farmers to step up production intensity and use their resources (land, water, labour) more fully and efficiently.

Figure 27.4: LDC Imports and exports of food and agriculture: 1961-2007



Source: Authors.

High transaction costs matter vastly in many developing countries. For instance, it costs only USD 40 to ship a tonne of fertilizer 9 000 km from the United States of America to coastal Mombasa, while it costs another USD 120 to take it from the port to Kampala, a distance of 500 km. The same high transportation costs apply for bringing a tonne of millet, sorghum or other produce from the farm to the consumer in urban areas or the ports at the coast. The high shipping costs for inputs have the same effect as a high import tariff, i.e. a tariff on fertilizer, feedstuffs, seeds, or diesel. These high transaction costs make inputs expensive for farmers and help explain the very low fertilizer and plant protection applications levels and ultimately very low yields in sub-Saharan Africa. On the output side, high transaction costs work like an export tax, squeezing profit margins for farmers and lowering the competitiveness relative to foreign farmers.

Expensive inputs, high shipment costs and high losses from farms to markets have undoubtedly lowered the competitiveness of domestic agriculture in many developing countries. At the same time, foreign suppliers have benefited from subsidies in the exporting markets and a transformation of the retail sector in the importing countries that resulted in a growing prevalence of higher foreign standards. These factors contributed to the growing trade deficit of many developing countries. The least developed countries (LDCs), i.e. the 50 poorest developing countries, have been hardest hit; their net imports of food and agricultural products have soared over the past 20 years (Figure 27.4) to a level of nearly USD 14 billion by 2007.

Investment in infrastructure pays off handsomely: Not all developing countries have neglected their rural infrastructure, and those who invested have reaped considerable rewards. Particularly countries in East Asia have invested substantially in rural roads and transportation facilities. China (Mainland), for instance, has increased investments in rural roads from RMB 35.8 billion to RMB 124.2 billion from 2001 to 2004. In parallel, new

Table 27.8: Investment in rural roads

	Baseline	Zero hunger	Increment
	Annual investment		
	billion USD		*million USD*
Developing countries	24.3	32.5	8 194
sub-Saharan Africa	2.8	5.2	2 409
Near East/North Africa	3.5	3.8	244
Latin America/Caribbean	6.1	8.0	1 808
South Asia	7.1	9.8	2 710
East Asia	4.7	5.8	1 022

Source: Authors.

bridges, pathways and rural water supplies were built and by 2006, 62 percent of villages were connected to their towns by paved roads. At the same time, investments in rural water supplies helped improve access to clean drinking water. Between 2001 and 2004 alone, the share of villages with access to tap water rose by 15 percent. More recently, the stimulus package to counter the effects of the global financial crisis has supported further improvements in rural infrastructure, improving links both within rural areas and the connections to Mainland China's growing urban consumer base. Despite its scarce land and water resources and rapidly growing urban food market with its shift in consumption patterns, Mainland China's farmers have managed to feed the country with stapes largely from its domestic agricultural base.

The additional investment in roads to reach zero hunger have been estimated at nearly USD 8.2 billion annually (Table 27.8). These investments will help raise agricultural efficiency and provide the necessary infrastructure to ship more inputs to farms and more produce to the final consumer. A better rural road network will also raise farmgate prices, lower losses and improve quality. Moreover, it will create jobs and incomes in rural areas for the construction and maintenance of roads and thus contribute to rural higher incomes overall.

A breakdown of the total incremental needs of USD 8.2 billion by region shows that South Asia will absorb the largest share of the total with more than USD 2.7 billion incremental investments. This reflects both the region's large agricultural base but also its significant needs to catch up to more adequate levels of road infrastructure. Relative to the baseline levels, the largest increments are needed for sub-Saharan Africa where infrastructure investments would have to rise by the factor of 1.9 to USD 5.2 billion annually (Table 27.8) relative to the baseline levels. In large measure this is owed to its poor current infrastructure endowment and underscores the particularly high need to raise agricultural productivity to reach the zero hunger goal in that region.

Rural electrification (US$ 4.1 billion): Not only rural roads but also rural electricity grids are unavailable and unreliable in many hunger-stricken countries. For instance, only 5 percent of Africa's rural population has access to electricity, while the rest depends on traditional fuels such as wood and manure for cooking, heating and light. In South Asia electricity consumption per person is the lowest of all regions. An inefficient power grid and obsolete

Table 27.9: Investment in storage, marketing and processing

Region	Annual investment		
	Baseline	Zero hunger	Increment
	billion USD		million USD
Developing countries	104.7	110.4	5 681
sub-Saharan Africa	10.2	11.5	1 282
Near East/North Africa	10.8	11.0	239
Latin America/Caribbean	22.4	22.9	487
South Asia	24.8	27.5	2 724
East Asia	36.6	37.5	948

equipment result in power losses that are 30 percent higher than in developed economies. Although empirical data for separate estimates for rural and urban infrastructure are hard to find, evidence based on household surveys points to a clear "infrastructural disadvantage" of rural areas relative to urban ones. It also points to a particular disadvantage of African and South Asian households as compared with those in other regions.

Upgrading and expanding rural electrification necessary to support the expansion of irrigation, processing and storage facilities in rural areas was estimated to amount to USD 4.1 billion annually. Sub-Saharan Africa and South Asia would have the largest investment needs, absorbing USD 1.2 and USD 1.4 billion per year respectively for investments in rural electrification.

Storage, marketing and processing (US$ 5.7 billion)

FAO estimates suggest that post-harvest losses alone account for 25-40 percent of total agricultural production in developing countries. Losses can even be higher for individual countries and individual crops particularly when bumper harvests yield output well in excess of the limited storage capacities. Building or improving storage facilities to reduce these massive losses is therefore an important element of this programme.

While reducing high losses is an important achievement in its own right, the benefits of better storage exceeds the mere reduction of production losses. Reducing losses ultimately means reducing pressure to raise output, and thus means fewer inputs such as fertilizer, seeds, power, or pesticides. It also means reduced pressure on natural resources, with less need to farm marginal land, forests, swampland and other precious habitats or to tap into scarce water resources. Better storage also provides a buffer for production shortfalls and thus helps reduce swings in market prices for farmers and consumers. And finally, adequate storage maintains the quality of farm produce, helps enhance food safety and thus allows farmers to fetch a higher price. These extra benefits can be further augmented if more and better storage is matched by investments in processing facilities and marketing chains. The integration of storage, processing and marketing activities is at the heart of the idea to build-up value chains and the efforts to allow farmers to reap a larger part of the final consumer expenditures. These expenditures can reach, depending on product and country, multiples of the amounts received by farmers for the primary product.

For developing countries as a whole, the necessary investments into better storage, processing and marketing have been pegged at annual amounts of USD 5.7 billion (Table 27.9).

Even a cursory inspection of the allocations in Table 27.9 reveals pronounced regional differences with the lion's share of the incremental needs allocated to South Asia and sub-Saharan Africa. This is not an unfamiliar pattern and reflects, in essence, the particular efforts needed to reduce hunger and the inadequacy of current storage and processing facilities in these two regions.

Development and conservation of natural resources (US$ 9.4 billion)

Food production, more than any other form of economic activity, relies on productive natural resources. The resource base for food production is nearly all-embracing, including cropland and pastures, forests and plantations, oceans and fresh water, as well as plant and animal genetic resources. The need to raise food production means that these resources must be used more intensively in the future and thus poses an increased risk for their degradation or complete destruction. Wind and water erosion can degrade fertile land, excessive irrigation depletes aquifers, ill-designed drainage systems result in water-logging and mono-cropping reduces soil fertility and ultimately destroys the genetic resistance against pests and diseases. Appropriate technologies, skilled labour, infrastructure and institutions in turn enhance their productivity and ensure that they can be used sustainably. This requires investments in sustainable production methods, efforts to preserve genetic resources and biodiversity and in skills and training to manage the resource base in a sustainable manner.

The annual incremental investments to develop and conserve natural resources have been estimated to amount to USD 9.4 billion of which USD 3.6 billion per year is needed for the extension and improvement of irrigation systems beyond the farm boundary (e.g. dams, canals) and the implementation of programmes that foster farmers' adoption of soil and water conservation practices. USD 600 million per year would be needed to conserve and use plant genetic resources. This would support international and national activities necessary to conserve, evaluate, make available and enhance the use of plant genetic resources, providing the basis for yield increases through crop breeding and better on-farm management of genetic resources.

The conservation of farm animal genetic resources, together with genetic improvement schemes for increased animal productivity through higher reproductive rates and better production per animal would require additional investments of USD 460 million per year.

Ensuring the sustainable use of the world's fisheries, while increasing production will require investments of an additional USD 2.4 billion per year in fisheries monitoring and protection and for the creation of alternative livelihood sources for fishermen and in aquaculture. As most wild fish stocks are fully exploited, about 70 percent of these investments will be used to conserve aquatic ecosystems and manage associated capture fisheries. Additional fish demand will be met mainly from aquaculture, in which relatively modest public investment will trigger large private investment commitments.

Incremental public sector investment needed to use forests in a sustainable manner is estimated conservatively at USD 2.4 billion per year. This would be used to protect forests from unauthorized or unplanned conversion, manage wild food sources in forests, develop alternative livelihood opportunities for food-insecure forest-dependent populations and minimize and offset the negative consequences of converting forest to agricultural land.

Building and expanding rural institutions (US$ 5.6 billion)

Institutions make investments work. Building and expanding support for institutions is needed in many areas, particularly for ensuring a functioning rural finance system, effective research and extension systems, guaranteeing land titles and tenure security or promoting rural mechanization. These demands have rapidly grown over the past decades while institutional capacities have stagnated. Many inefficient public institutions have been destroyed in the course of structural adjustment programmes but have never been replaced by more efficient ones, neither public nor private. This has left a huge institutional void in many developing countries, particularly in sub-Saharan Africa, and explains the significant requirements for a better institutional environment. Overall, the needs have been estimated to add up to a total of USD 3.6 billion annually.

Institutions are also at the heart of creating new and strengthening existing absorptive capacity for investments. Provided that an appropriate legal and regulatory framework is in place, the institutions ensure that investments are allocated efficiently. For instance, new research and development funds can only be allocated efficiently if an institutional infrastructure exists that helps transfer new technologies and know-how from research centres to experimental stations to the farm. And, to ensure that the newly-generated benefits can be shared by the poor, improved and expanded extension services are inevitable. Likewise, enhanced mechanization requires institutions that provide quality assurance, consumer (farmer) safety and vocational training for farmers and operators to be fully effective. Institutions are also critical for establishing formal property rights or for creating legal titles to land and other assets, which is, in turn, a necessary precondition to establish collaterals for much-needed loans. Indeed, most important in the context of this investment programme is that a functioning rural finance infrastructure ensures that the proposed capital flows can be channelled efficiently and without major "losses" to the final investment destination.

Rural finance (US$3.6 billion) The lion's share of the overall funds required for building or rebuilding institutions will be absorbed by the creation and deepening of the rural finance infrastructure necessary to channel the proposed funds into rural areas. In many countries, particularly in sub-Saharan Africa, there is a need to build a functioning rural finance system from scratch.

The first challenge for the rural finance infrastructure will be channelling the additional USD 42 billion for rural and agricultural development efficiently into rural areas; if implemented successfully, these public funds are expected to crowd-in private investments that could reach three or four times the volume of the initial public investments. In addition, there is the need to establish or strengthen appropriate fiduciary systems that ensure that proposed investment flows are reaching their stated destinations, and that their performance can be monitored, controlled and audited. The costs for building up the rural finance infrastructure and the related fiduciary systems are difficult to gauge and the underlying calculations are based on rough rules of thumb rather than precise parameters. What is more, the extent and efficiency of the existing finance infrastructure varies widely from country to country, ranging from extensive coverage in many Asian economies to a virtual absence in many sub-Saharan African countries. Assuming additional overall annual public investments of USD 42 billion and incremental costs between 5 percent (East Asia) and 20 percent (sub-Saharan Africa) of the investment flows to establish a new or expand an existing rural finance infrastructure, the creation and operation of the rural finance sector needed for this programme would amount to USD 3.6 billion annually.

The high additional investment costs are also a reflection of the particular challenges facing developing countries' rural finance systems in general. These include high transaction costs associated with dispersed populations and the seasonality of household income flows, which typically peak at harvest time but fall away at other times, making credit repayment which is not tied to seasonality factors a challenge for poor households. Other problems include a lack of collateral owing to a widespread absence of clearly defined property rights as well as insufficient or completely missing cadastre and land title systems. Even where land titles exist, they are seldom transferable and so cannot (or not easily) be used as collateral. The situation is particularly serious in much of sub-Saharan Africa where a combination of high production risk, scarce borrower information, cumbersome legal procedures and high transaction costs means that many financial service providers are reluctant to serve poor farmers and business people, leaving the market open to informal institutions and operators like traders and processors who may well be less scrupulous and supportive in the way they operate.

This context provided the rationale for the state subsidized and targeted agricultural finance schemes that flourished in the 1970s and 1980s but which, with a few exceptions, turned out to be rather ineffective and inefficient. By contrast, microfinance programmes (credit, savings and, to a lesser extent, micro-insurance and leasing services) have been more successful; they have proven effective in creating access to small loans and helping reduce poverty in rural areas. Given the typically small size of loans and the short repayment periods, microfinance schemes have been particularly important and successful in financing working capital and items with short depreciation periods (while they are less important for financing long-term investments). Investments in capital goods of longer life spans and larger amounts require a broader range of different rural and agricultural finance institutions, including rural credit unions, specialized development banks or rural finance co-operatives.

Institutions for tenure security and secure land titles (US$ 0.8 billion) The rationale for investing in land title and land tenure institutions is twofold: first, there is considerable catch-up potential for improvements seeing as insecure land tenure is pervasive in most developing countries; and second, systems that ensure formal ownership titles are often missing.

At the same time, the benefits possible from improved tenure security and formal ownership rights are manifold: (i) ownership rights and tenure security are the basis to use land as collateral for investments and thus allow farmers and tenants to gain access to formal credit markets; (ii) secure tenure and ownership is also a necessary precondition for the adoption of sustainable farming practices, for long-term investments in land conservation and erosion control; (iii) secure titles and tenure help farmers reduce the amount of resources needed to defend the access to land (empirical evidence suggests that this is a particularly beneficial for smallholders, who can save considerable amounts of resources and spend more time in local labour markets thus significantly improve their non-farm incomes); and (iv) secure land titles lower transaction costs or, in any case, make transactions possible at all (this allows smallholders who decide to leave their farm to sell the land or receive compensation in the case of expropriation; likewise, secure tenure rights allow them to return to their plots and enable them to seek temporary jobs in urban areas). These benefits suggest that institutional investments in secure land and tenure rights are a necessary precondition for the considerable investments proposed in land conservation and the protection of natural resources.

The overall investment requirements to establish new and enhance existing land title and land tenure systems have been estimated at USD 0.8 billion annually. In principle, these investments comprise two components: first, establishing land registers, cadastre systems and enacting the legal code that allows to establish and enforce property rights; and second, creating the relevant institutions as such, ensuring that they have universal outreach to cover remote areas and establishing the legal framework needed to enforce property and tenure rights and to interpret these rights so that possible conflicts are avoided from the outset.

Institutional needs to promote rural mechanization (US$ 1.2 billion): The baseline investment projections to 2030/2050 suggest that mechanization will be the single most capital-intensive investment area, absorbing one third of all capital needs of primary agriculture over the next four decades. These investments include a whole range of different items, notably tools, tractors, implements, combines and many other forms of farm equipment and machinery. Clearly, much of the capital needs for mechanization will have to come from private sources. Farmers themselves must decide on the extent, type and timing of such investments on the basis of the promised returns. On the face of it, a role of the public sector is therefore hard to discern. In fact, subsidies for mechanization could even lead to overinvestment and ultimately to a misallocation of private and public capital.

There are, however, factors that can result in a marked underinvestment in mechanization or unduly stifle the profitability of private investments particularly for smallholders. For a small farmer, purchasing a tractor or even a simple tool or implement is often a highly capital-intensive exercise and individual holdings are generally too small to provide the scale that would be required to reduce fixed costs for a profitable investment proposition. Even where such investments are profitable, the liquidity requirements for these big capital items can be too demanding to make the investments viable in practice. To overcome these constraints, the zero hunger scenario assumes public support of about USD 1.2 billion in two distinct areas:

Building and re-building institutions for mechanization

The crucial importance of rural financing institutions has been discussed. The important elements include a range of measures such as cadastre systems, clearly defined land and property rights and the operation of rural finance institutions as such. It should suffice here to underline that they are particularly important for capital-intensive investments such as mechanization and that public expenditures to establish these institutions have already been accounted for.

Not accounted for but also important are the benefits that can be provided by mechanization-specific institutions. For individual countries, they include the organization and operation of tractor-hire and tool-hire schemes, schemes to promote group ownership, machinery-hire services and start-up assistance for private service providers. A growing mechanization of agricultural production will ultimately also require growing expenditures for vocational training, farmer field schools, training courses for farmers and operators of equipment. On a regional basis, important benefits will come from regional testing centre and rural mechanization lead clusters (RMLC). RMLCs have played and important role in the mechanization of Asia's agriculture, particularly in providing quality assurance to farmers, importers and distributors of equipment, client (farmer) safety and protection as well as market intelligence and transparency. The provision of such services and schemes will also be important for successful mechanization in other regions, particularly in sub-Saharan Africa. The zero hunger scenario assumes that requirements to establish and run these mechanization institutions will amount to about 8 percent of the overall capital needs for mechanization. This share should suffice to establish and run both national and regional mechanization schemes and institutions.

Table 27.10: Pro-poor R&D priorities in plant breeding				
Crop	Biotic stress factors		Abiotic stress factors	
Wheat	Disease: Leaf and stripe rusts; Fusarium head blight, powdery mildew and Weed competition	insects: Hessian fly and weevils	Heat	Drought
Maize	Weed competition	Insects: stem borers, including storage grain insects	Low soil fertility	Drought
Cassava	Disease: (Cassava mosaic virus, Cassava brown strike diseases, Cassava bacterial blight) and insects (Mealy bug, Mites and Trips)	Weed competition	Low soil fertility	Drought
Rice	Disease: (Leaf blast, bacterial Leaf blight, Sheath blight, Bacterial leaf streak) and virus (rice tungro and Rice Yellow Mottle Virus)	Insects: Brown plant hopper, Stem borers, Gall midge	Drought, Heat and cold	Flood, Alkali and salt injuries
Sorghum	Disease: anthracnose, grain moulds, leaf blight, rust, ergot, head smut, loose kernel smut, covered kernel smut, downy mildew, charcoal rot, maize stripe virus, maize mosaic virus, striga	Insects : sorghum shoot fly, spotted stem borer, sorghum midge, ear head bug, green bug, sorghum mites,	Drought, low temperature, high temperature, salinity, acidity, water logging, low soil fertility	
Pearl millet	Disease: downy mildew, ergot, smut, blast, rust, striga	Insects : white grubs, shoot fly, stem borer, head minor, Helicoverpa, blister beetles	Drought, high temperature, salinity	water logging, low soil fertility
Pigeon peas	Disease: wilt, sterility mosaic disease, phytophthora blight, alternaria blight, collar rot, dry root rot, cyst nematode	Insects : Helicoverpa, pod fly, pod wasp, blister beetles, Maruca, pod bug, Lima bean pod borer, flower thrips, bruchids	Drought, soil acidity, salinity, water logging	
Chickpea	Disease : Ascochyta blight,sclerotium stem rot, botrytis gray mold, fusarium wilt, dry root rot, collar rot, stunt, nematodes	Insects : Helicoverpa pod borer, leaf miner, aphids, bruchids	Drought, low temperature, high temperature, salinity	Fe deficiency
Groundnut	Disease: early leaf spot, late leaf spot, rust, bacterial wilt, bud necrosis, nematodes, (A. flavous colonization, aflatoxin contamination-more of quality aspect)	Insects: white grubs, Spodoptera, red hairy caterpillar, Helicoverpa mites, jassids, aphids, thrips, leaf miner	Drought, salinity	Fe and Zinc deficiency
Barley	Disease: Net blotch, Powdery mildew, yellow and stem rust, Barley yellow dwarf virus (BYDV), Scald	Quality (malting and animal feed)	Drought	Heat and cold
Potato	Disease: Late blight P. infestans Virus(es) PVY, PLRV Bacterial wilt R. solanacearum	Insects: Leaf miner fly Colorado potato beetle Potato tuber moth, cyst nematodes	Heat/salinity	Drought; frost
Sweet potatoes	Disease: Sweetpotato virus disease complex (SPVD), Sweet potato feathery mottle potyvirus (SPFMV) and sweet potato chlorotic stunt crinivirus (SPCSV)	Insects: specie of weevil, Cylus spp.	Drought	Salinity

Limited and time-bound incentives for a sustainable mechanization of small farms

In addition to building the institutional basis for an efficient mechanization, smallholders can vastly benefit from support for an initial mechanization step. These payments should be time-bound and limited in amount and may be made contingent upon the purchase of equipment that ensures the adoption of good, i.e. sustainable farming practices and thus help create an implicit environmental service. Such implicit payments for environmental services (PES) could promote practices such as conservation farming and no-till systems instead of ploughing and traditional tillage, they would favour row-planting over broadcasting seeding practices, or support permanent control traffic farming and other techniques that help to enhance the sustainability of agricultural production and reduce the carbon footprint of agricultural production. The environmental benefits of no-till farming are immediately evident on fragile erosion-prone soils particularly in tropical regions. Equally obvious are the private benefits of a shift to sustainable farming practices for individual farmers. A shift from ploughing to no-till agriculture alone reduces the on-farm power needs between 50-70 percent; these benefits would also allow to limit the payments to an initial stage and to phase them out over time.

Conclusions

Hunger is above all a manifestation of poverty. Around 75 percent of the poor live in rural areas and many depend on agriculture for their livelihoods. They eke out a living on farms of often less than two hectares, work as small entrepreneurs or earn meagre wages in the agriculture-related processing, storage, seed or feedstuffs sectors. They are poor because they rely on too few and too unproductive assets. A profound and prolonged lack of investment in agriculture has restrained the overall productivity of the sector, sometimes to the extent that it no longer stands as a viable base for poverty reduction. A lack of investment has also reduced the ability of farmers to cope with price volatility. Moreover, the cyclical tendency of investment flows appears to have pronounced price peaks and troughs.

The twin-track approach of affording the vulnerable access to more productive resources and support by safety nets is the basic idea of this programme. The programme also promotes the adoption of more sustainable production methods and investment in the conservation of natural resources, institutions, infrastructure and job creation in rural areas outside of agriculture. It invests in people and physical assets alike; it addresses both the need to raise output and productivity and the need to improve the sustainability of production methods. Furthermore, given the impossibility to sequence public investments counter-cyclically, the programme suggests that public investment should be allocated in equal instalments.

If implemented, a natural corollary of the programme would be to lower the vulnerability of those most at risk from exogenous shocks, both weather-related and economic ones, especially those which lead to irreversible harm to societal systems and human capital.

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A timely publication as world leaders deliberate the causes of the latest bouts of food price volatility and search for solutions that address the recent velocity of financial, economic, political, demographic, and climatic change. As a collection compiled from a diverse group of economists, analysts, traders, institutions and policy formulators – comprising multiple methodologies and viewpoints - the book exposes the impact of volatility on global food security, with particular focus on the world's most vulnerable. A provocative read.