SAFEGUARDING FOOD SECURITY IN VOLATILE GLOBAL MARKETS

EDITED BY

ADAM PRAKASH

FIAT PANIS

ISBN 978-92-5-106803-8

Cover design by Giancarlo de Pol
Cover photo (centre) ©FAO/Ami Vitale
Typesetting and layout by River Valley Technologies (river-valley.com)

Safeguarding food security in volatile global markets

Edited by Adam Prakash

Food and Agriculture Organization of the United Nations, Rome, 2011

Contents

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

[1] Adam Prakash, Statistics Division (FAO); Christopher L. Gilbert, Department of Economics, University of Trento, Italy.

Figure 3.1: Global affordability of food: 1990-2010

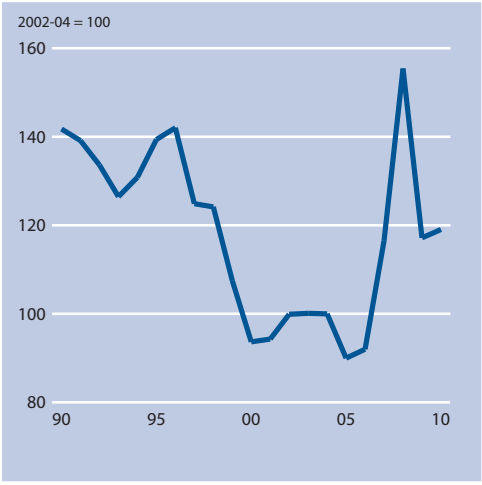
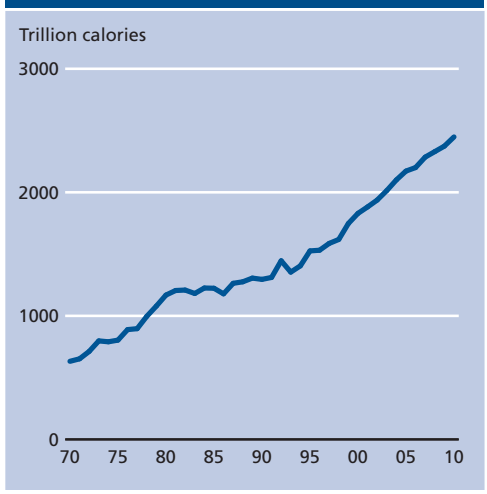


Figure 3.2: Global food trade (trillion calories): 1970-2010



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.

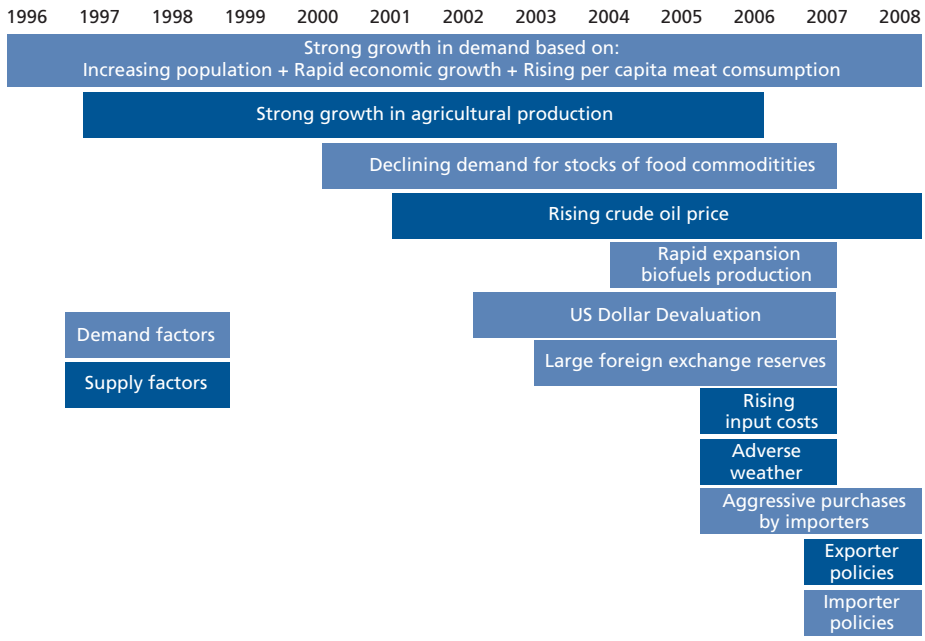
Contrary to common perceptions, macroeconomic factors were important in determining the 1973-74 crisis. This took place at the end of Viet Nam war that resulted in enormous macroeconomic imbalances in the world's leading economy of the United States of America. The crisis also began to unfold after the 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).

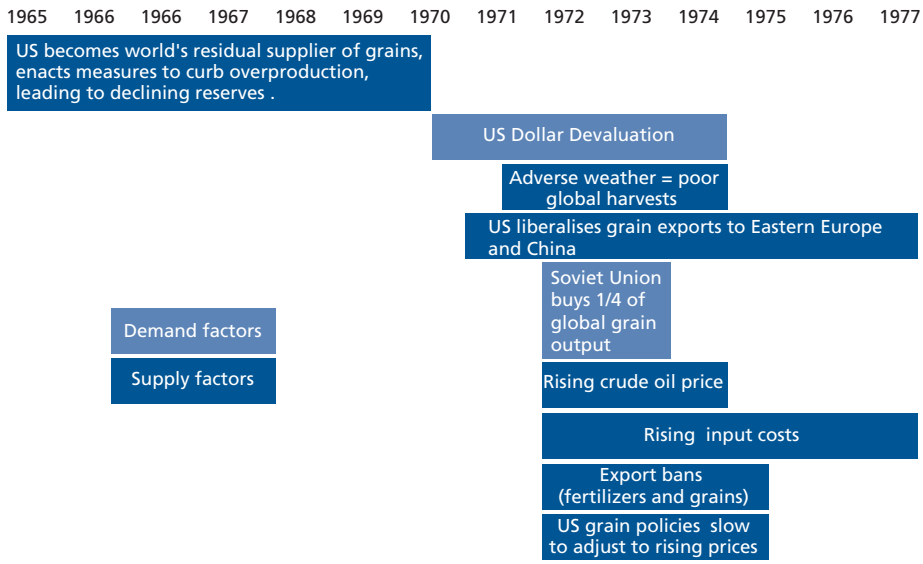
limitations, including a lack of observations and the presence of "discrete jumps" precludes a robust decomposition and attribution of causality. In addition, that expectations of economic agents and the interactions between causal factors are critical in price determination but unobserved further complicates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

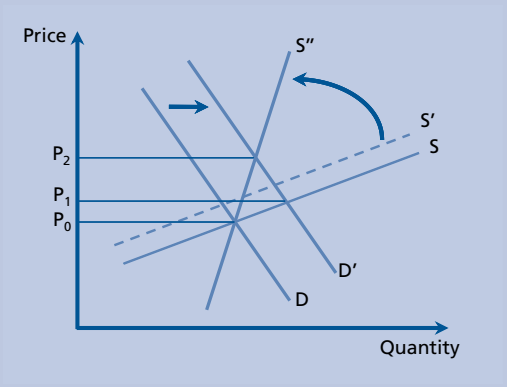
First, periods of escalating prices tend to succeed periods of low investment, which is often the outcome of a long-lasting decline in prices. Falling prices provide little incentive for investment that will likely curtail productivity growth and reduce the capacity of world agriculture to respond to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

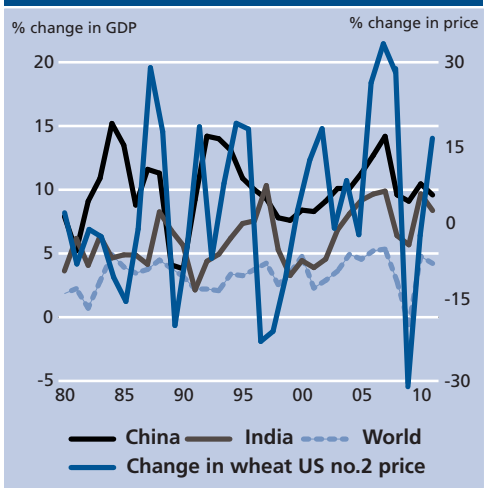
There is a tension evident in analysis of both the 1973-74 and the 2006-08 crisis between focus on market-specific factors and discussion of global factors (world monetary conditions, etc.). Market-specific factors can explain why the prices of some products rose and others did not, but macroeconomic 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):

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

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.

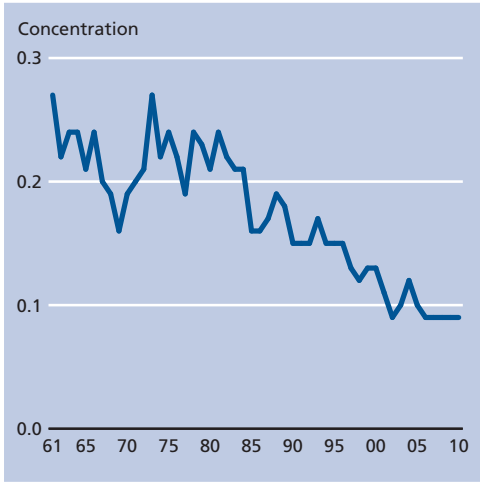
Similar issues were reported in Kenya, which is vulnerable to increases in world fertilizer and energy prices because all of its fuel and fertilizer are imported. Flat farmgate prices (despite rising consumer prices) and the increased costs of agricultural inputs (fertilizer prices tripled in six months) 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.

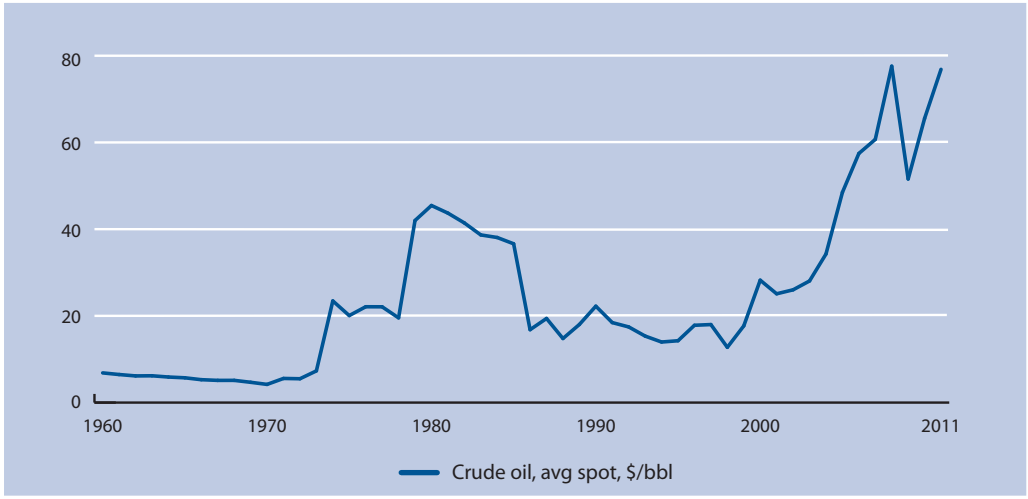
As long as production shocks are uncorrelated, this system will bring about benefits, principally in terms of efficiency savings. However, falling inventory levels reduce supply responsiveness to global demand shocks or to production shocks in major exporting countries.

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.

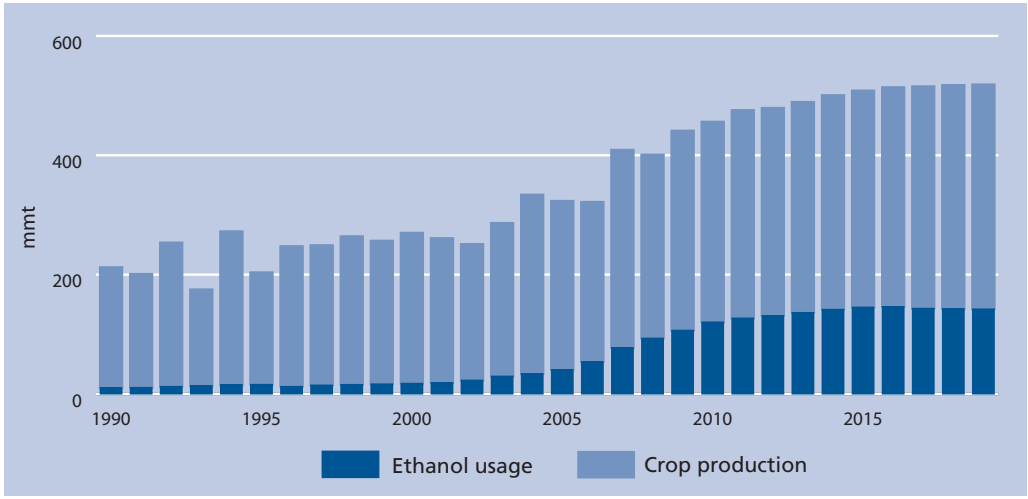
More important is that diversion of food crops for biofuels production (see Figures 3.10 and 3.11) has raised potential demand for food commodities, which will increase demand variance. However, through incentivizing change in land use, it has also had indirect effects on wheat and soybean prices and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

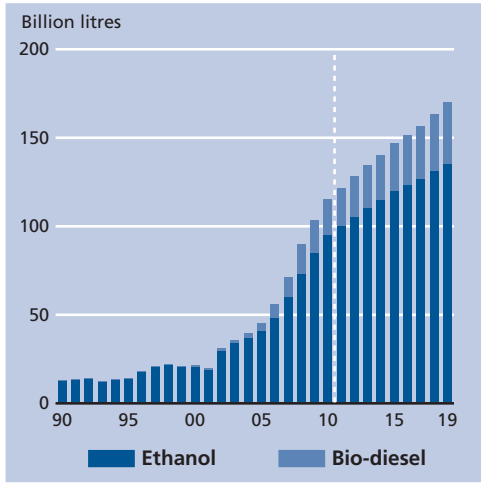


Source: OECD-FAO (2010).

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.

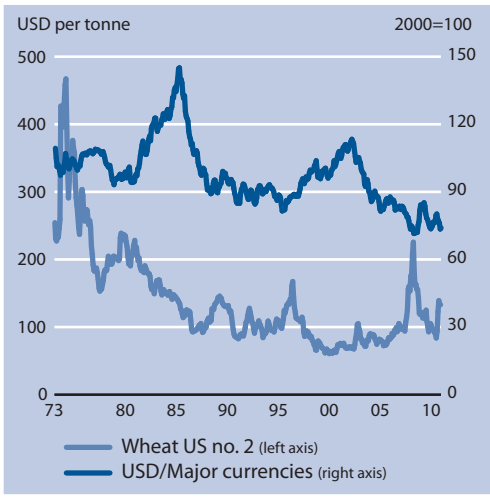
Efficient-markets theorists argue that commodity price rises have been driven completely by market supply and demand fundamentals and that futures markets form the mechanism by which information about fundamentals becomes incorporated in market prices. A related argument is that monetary expansion or 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

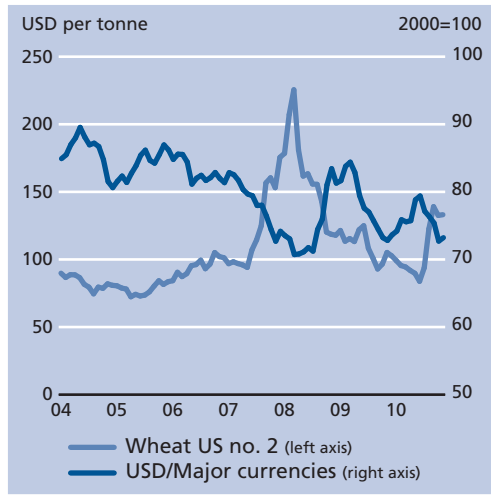
[4] This transmission of the monetary impact on storable commodity prices is determined by inventory behaviour. Inventory accumulation and depletion is shaped by an arbitrage condition that, in equilibrium, precludes a difference between the interest rate and the "convenience yield" (the sum of expected 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

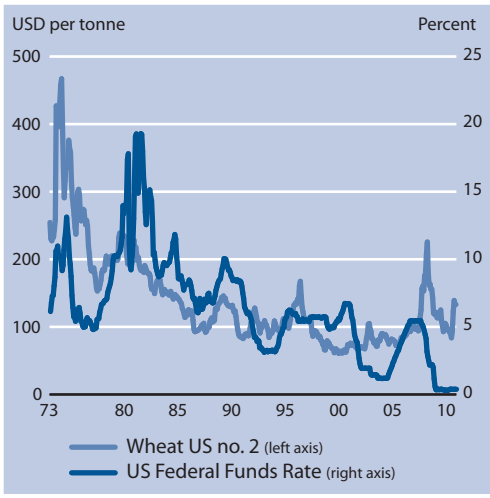
(a) US Dollar exchange rate and wheat prices (annual): 1973-2010



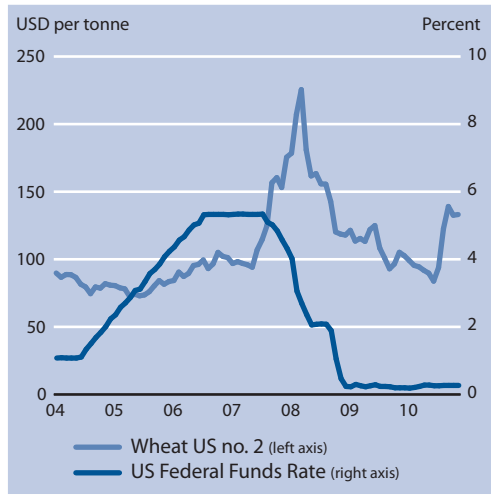
(b) US Dollar exchange rate and wheat prices (monthly): 2004-2010



(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.

[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.

References

Awokuse, T. 2005. Impact of macroeconomic policies on agriculture, *Agricultural and Resource Economics Review*, 34: 226–237.

Baffes, J. 2007. Oil spills on other commodities, *Resources Policy*, 32(3): 126–134.

Bordo, M. 1980. The effect of monetary change on relative commodity prices and the role of long term contracts, *Journal of Political Economy*, 88: 1088–1109.

Chambers, R. & Just, R. 1982. An investigation of the effects of monetary factors on agriculture, *Journal of Monetary Economics*, 9: 235–247.

FAO 2002. Consultation on agricultural commodity price problems, *Commodities and trade division paper*, Rome, Rome.

——— 2009a. *The state of agricultural commodity markets,* Rome.

——— 2009b. *The state of food insecurity in the world 2009: Economic crises - impacts and lessons learned,* Rome.

——— 2010. *The 2007-2008 food price episode impact and policies in Eastern and Southern Africa,* Rome.

Frankel, J. A. 1986. Expectations and commodity price dynamics: the overshooting model, *American Journal of Agricultural Economics*, 68: 344–348.

——— 2006. The effect of monetary policy on real commodity prices, *NBER Working Papers 12713*, National Bureau of Economic Research, Inc.

Friedman, M. 1953. *Essays in Positive Economics*. University of Chicago Press, Chicago.

——— 1960. *A Program for Monetary Stability*. Fordham University Press, New York.

——— 1961. The lag in effect of monetary policy, *Journal of Political Economy*, 65: 617–621.

Gilbert, C. L. 1989. The impact of exchange rates and developing country debt on commodity prices, *Economic Journal*, 99: 773–784.

Gilbert, C. L. & Morgan, C. W. 2010. Food price volatility, *Philosophical Transactions of the Royal Society B*, 365: 3023–3034.

Hawkes, C. & Murphy, S. 2010. Overview of global trade, in *Trade, Food, Diet and Health: Perspectives and Policy Options*, ed. by Hawkes, C., Blouin, C., Henson, S., Drager, N. & Dube, L. Wiley-Blackwell, Oxford.

Mitchell, D. 2008. A note on rising food prices, *Policy Research Working Paper Series 4682*, The World Bank.

Nissanke, M. 2010. Commodity markets and excess volatility: Sources and strategies to reduce adverse development impacts, in *Paper presented to a CFC Conference*, Brussels.

OECD-FAO 2010. *Agricultural outlook 2010-2019,* FAO-OECD, Paris-Rome.

O'Hara, M. 1995. *Market Microstructure Theory*. Blackwell, Oxford.

Ridler, D. & Yandle, C. 1972. A simplified method for analyzing the effects of exchange rate changes on exports of a primary commodity, *IMF Staff Papers 19*, IMF, 559-578.

Samuelson, P. A. 1973. Proof that properly discounted present values of assets vibrate randomly, *Bell Journal of Economics and Management Science*, 4(2): 369–374.

Schmidhuber, J. 2006. *Impact of increased biomass use on agricultural markets, prices and food security: A longer term perspective,* Global Perspectives Unit, FAO.

Stigler, M. & Tortora, P. 2011. Food crisis: did prices rise faster than they fell?, in *Research Topics in Agricultural and Applied Economics (Volume 2)*, ed. by Rezitis, A. N. Bentham.

Svensson, L. 1985. Money and asset prices in a cash-in-advance economy, *Journal of Political Economy*, 93: 919–944.

Taylor, J. B. 1995. The monetary transmission mechanism: An empirical framework, *Journal of Economic Perspectives*, 9(4): 11–26.

Trostle, R. 2008. Global agricultural supply and demand: Factors contributing to the recent increase, *Food Commodity Prices Outlook Report WRS-0801*, ERS, USDA., Washington DC.

UNCTAD 2009. *Trade and development report 2009,* Geneva.