ALL ACP AGRICULTURAL COMMODITIES PROGRAMME

IMPACT ASSESSMENT OF ALTERNATIVE APPROACHES TO MITIGATING TRADE RELATED RISK EXPOSURE IN ESA GRAIN MARKETS (MAIZE)

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Abbreviations and acronyms

CBOT	Chicago Board of Trade
CCC	Commodity Credit Corporation
CME	Chicago Mercantile Exchange
Comesa	Common Market for Eastern and Southern Africa
Comex	Commodity exchange
CRDB	Cooperative and Rural Development Bank
CV	Coefficient of variation
DRC	Democratic Republic of Congo
EAC	East African Community
EAGC	Eastern African Grain Council
ESA	Eastern & Southern Africa
FAO	Food and Agriculture Organization of the United Nations
FCI	Food Corporation of India
FEWS NET	Famine Early Warning Network
GMO	Genetically Modified Organisms
HAFED	Haryana State Cooperative Supply and Marketing Federation Limited
KACE	Kenya Agricultural Commodity Exchange
Kg	Kilogram
KNCU	Kilimanjaro Native Cooperative Union
NAFED	National Agricultural Marketing Cooperatives Federation of India
NASFAM	National Smallholder Farmers' Association of Malawi
NBHC	National Bulk Handling Corporation
NCDEX	National Commodity & Derivatives Exchange
NCPB	National Cereals Produce Board
NFRA	National Food Reserve Agency
NSEL	National Spot Exchange Ltd.
P4P	Purchase for Progress
RATIN	Regional Agricultural Trade Information Network
RSA	Republic of South Africa
SAFEX	South African Futures Exchange
SAGCOT	Southern Agricultural Growth Corridor of Tanzania
SIDA	Swedish International Development Agency
UCE	Uganda Commodity Exchange
USA	United States of America
USAID	United States Agency for International Development
WFP	World Food Program
WRS	Warehouse Receipt System

Executive summary

Governments in East Africa have tended to intervene heavily in markets for their key food staple, maize, both through marketing board operations and discretionary trade policy instruments, purportedly to protect producers and consumers from price risk. In effect, such interventions can be counter-productive, exacerbating the risks faced by participants in the grain value chain, not to mention consumers – especially the poorest amongst them. This paper explores the impact of intervention policies on maize markets in three countries: Kenya, Tanzania and Uganda. It also examines alternative approaches to mitigating risks for maize producers and consumers in the region.

Maize is the major grain in all three countries. As it is a rainfed crop, annual production fluctuates strongly but in a way different from country to country. International trade in maize is therefore important in these countries to help level out year-to-year fluctuations, and there is a large scope for regional trade. The governments of the three countries, through the East African Community, have in fact endorsed a "common maize market", but implementation falls somewhat short of the ideal. The Governments of Kenya and Tanzania continue with measures that hamper intra-regional maize trade; measures that can often be avoided through informal trading mechanisms. Informal maize trade is therefore, by many accounts, much higher than formal trade flows.

The resultant distortions of official statistics make an econometric analysis of the impact of market interventions rather difficult. Analysis of maize prices shows that they are volatile, but that most of the price movements are actually predictable from past price movements. Thus, private sector actors should be able to adjust their decisions in order to protect themselves from price volatility, and there is little reason for an outside agency (e.g., government) to try and act on the level of price volatility itself (e.g., by market interventions). Maize markets in the region are reasonably well-integrated despite government trade interventions (indicating the strength of informal trade), with Nairobi acting as the main reference center which drives price developments in other parts of the East African region.

Better analysis would be possible with better data: longer price series with more frequent (weekly rather than monthly) observations; data on transport costs; data on informal trade. But most important in the short run: improved information on policy interventions. As it is, even government officials at times do not know what interventions are in place, let alone the private sector. The establishment of a food policy observatory empowered to monitor and report such interventions would help not just researchers, but would be of direct use to grain traders and processors.

Policy interventions have been frequent in both Kenya and Tanzania, where governments use trade policy and market boards as tools to influence prices on maize markets. Both countries have normally high import duties for imports from outside the region which are reduced or eliminated when governments see fit, and both use export bans when they feel that there is a local maize shortage. In both countries, there are also a number of non-tariff barriers (including a ban on GMO maize), with cumbersome import/export procedures. Uganda has stable trade policy when it comes to maize (the only significant barrier to trade is a ban on GMO maize), and does not operate a marketing board, or even a Food Reserve Agency.

Policy uncertainty is just one of the risks to which the maize sector in East Africa is exposed. Risk exposure is a problem. For example, farmers' response to risk depends on their ability to carry risk, which is a function of their overall wealth. The poorest farmers therefore tend to be the most risk

averse, so risk exposure is likely to perpetuate and reinforce rural income inequalities. Risks are exacerbated by weak physical and institutional infrastructure, which also make it more difficult to manage risks (e.g., poor road infrastructure hinders maize movements across regions; underdeveloped maize financing systems hinder seasonal storage). Some risks are difficult to avoid (e.g., weather), but the policy-induced risks, particularly in Kenya and Tanzania, could be reduced by better decision-making. Unpredictable import duty levels and marketing board interventions – and to a lesser extent, unpredictable procurement decisions from the World Food Programme, the largest single maize buyer in the region – prevent the private sector from taking forward positions (including taking early decisions to import maize in the face of an impending shortfall), discourage farmers (e.g., Ugandan farmers could produce much more maize if they were more certain of the market), and make maize storage risky.

How to deal with these risks? A number of efforts have been ongoing. One is the introduction of warehouse receipt finance, which facilitates storage (giving farmers greater flexibility in deciding when to sell, and stabilizing intra-seasonal prices). There have been pilots in all three countries, and while use in the maize sector is so far small, there has been encouraging progress. Although maize is not the most suitable product for contract farming arrangements, a large experiment has started in Tanzania. Some banks in the region have developed expertise in the use of futures and options (for coffee and cotton), and once a maize futures contract that meets the needs of East Africa has been introduced, they will be able to support its distribution. Weather index insurance pilot project have been started.

Intervention, where it occurred, was undertaken broadly to balance between three socio-economic goals: remunerative farmer income, food security/consumer protection, and protecting producers and consumers from excessive price volatility. These objectives could be better met if governments were to step back from interventionist practices and commit to a trade policy framework that leverages to the extent possible on the potential of market-based instruments.

This trade policy framework requires several components:

- policies and supportive actions that permit market instruments to operate at their best;
- safety-net mechanisms for, on the one hand, producers, and on the other consumers;
- policies that ensure that the transaction costs from farm to fork are as small as possible, to reduce the inherent tension in the otherwise conflicting objectives of protecting both producers and consumers; and
- mechanisms to influence price volatility by either reducing transmission from international markets, or directly intervening in domestic maize supply/demand.

How these various components can be elaborated into concrete action is elaborated in some detail in the report. All this still requires an active role of the government, and much support from the international donor community: considerable institution-building is necessary.

Introduction

In the East African maize trade, governments have tended to intervene heavily in markets both through marketing board operations and discretionary trade policy instruments, primarily with a view to reducing the risks of national level food insecurity. This paper explores the impact of such policies on maize markets in three countries: Kenya, Tanzania and Uganda. The governments of the three countries, through the East African Community, have a fairly well-integrated maize market, and have in fact endorsed a "common maize market". In addition to trade policies, the paper discusses alternative approaches to mitigating risks in East African maize markets, and how these could be implemented.[1]

African farmers, traders, processors and consumers are exposed to a wide range of risks. Agricultural production is vulnerable to factors such as weather (including catastrophic weather events) and disruptions in input supply. Supply chains are fragile, resulting in large farm-to-fork losses, high transaction costs and frequent market disruptions, with many supply chain operators suffering from a lack of information, weak finances and poorly developed infrastructure. National prices are not only affected by national supply/demand factors, but also by global price developments and a range of macro-economic, fiscal and regulatory policies and developments (e.g., exchange rate fluctuations, crop and sales taxes, licensing regimes). This combination of institutional, market and financial risks that affect grain markets and trade has a particularly negative impact on poor households that are forced to use a variety of informal mechanisms to cope with income and consumption risk, including diversification of cropping patterns, off-farm employment, food storage and sale of assets during hard times.[2]

It is therefore not surprising that governments may wish to supplement such informal risk management mechanisms with national policies – developing countries are no different in this regard from developed ones. However, countries that cannot afford to maintain expensive safety nets (like the European Union's Common Agricultural Policy) instead tend to rely on border measures – in particular, trade measures such as the discretionary use of import licensing and export bans – as well as marketing board interventions. The latter, though they were extensively curtailed under the Structural Adjustment Programs of the 1990s, appear to have grown in scope and influence since the turn of the millennium.

Due to under-resourcing of statistical and monitoring agencies, these trade measures have often not been supported by sound intelligence on the actual state of grain markets, and more importantly, are often based on a poor understanding of grain market functioning. Several researchers have argued that such interventions can be counter-productive, exacerbating the risks faced by participants in the grain

[1] This follows up on a key theme of the workshop on the "Use and Impact of Trade and Domestic Policy Interventions on Cereal Value Chain Stakeholders in Eastern and Southern Africa" organized in Jun 2009 in Dar Es Salaam by the Eastern Africa Grain Council (EAGC) in collaboration with FAO and the Swedish International Development Agency (SIDA). Six country studies commissioned by FAO during 2008 (South Africa, Zambia, Kenya, Malawi, Tanzania and Mozambique) were presented at the meeting. These studies reviewed trade and other associated policies in the six countries and one of the main findings was the predominant role of "pricing and marketing policies" as the most widely used instruments to encourage production of, and influence trade in maize. These policies were seen as increasing uncertainty and reducing incentives for stakeholders to invest in and use alternative market based risk management mechanisms.

[2] Karugia et al., 2009a.

value chain, not to mention consumers – especially the poorest amongst them.[3] Evidence from various East and Southern African countries shows that maize prices are generally more unstable in countries that pursue interventionist policies and restrict grain trade than in those with open borders.[4] Similarly, maize prices are less predictable where countries apply restrictions to grain trade, as compared to countries with open border policies. This indicates a prima facie case for improving government-private sector coordination to improve market functioning and reduce price instability.

The urgency of improved policy in this regard is heightened by the rising food prices of late. These have been a major cause for concern as these impinge on food security. A sudden surge in food prices has increased the number of poor people globally, though the impacts have differed across various countries. A recent study[5] estimates that between June and December 2010, the average poverty changed by 1.1 percentage points in low income countries and 0.7 percentage points in middle income countries and there was a net increase of 44 million people falling below the US$ 1.25 per day extreme poverty line. The achievement of the Millennium Development Goals will remain a dream if food insecurity continues worsening.

Building on previous work to appraise the effectiveness of both traditional government-led as well as market-based approaches to mitigate maize price risk in Kenya, Tanzania and Uganda, this report aims to:

- Identify the main features of risk exposure in the maize sector
- Document the use and assess the effectiveness of trade policy as an instrument for risk mitigation
- Assess the implications of introducing alternative market based risk management mechanisms in a scenario of restrictions on the use of discretionary trade policy interventions.

The report starts with an overview of the grain sector (with a particular focus on maize) in Kenya, Tanzania and Uganda and the trade relationships among the three countries. Chapter 2 analyzes maize price volatility, market integration and price formation. Then, the typical risks in the grain sector are discussed, with reference to the actual situation in the countries studied where relevant. The fourth chapter looks at the ways in which one may manage these risks. Chapter five reviews how trade policy has been used in East Africa as a tool to influence maize markets, and how market stakeholders view the effectiveness of past policies. Chapter six concludes with a discussion of possible risk management approaches for the East African maize sector, and what adoption of such approaches would imply for discretionary trade policy interventions.

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[3] Jayne and Tschirley, 2009.

[4] "Do Government efforts to stabilise food prices do more harm than good? In a word, "yes". (...) Trade barriers and public grain reserves have increased food price instability. Government trading operations have been large and unpredictable. Private traders have been hesitant to compete against subsidized public enterprises and have been reluctant to invest in seasonal storage and grain trading. (...) Maize price volatility declined sharply in Kenya since it adopted the - *maize without borders* - policy of the EAC in January 2005." (Maize without Borders in Africa -
DFID Funded Research on the Food Crisis). See also Chapoto and Jayne, 2010; and Jayne, Chapoto and Govereh in Sarris and Morrison (eds.), 2010.

[5] Ivanic et al, 2011.

Chapter 1
An overview of East African maize markets[6]

Maize is the main foodgrain in East Africa. Together, all grains contribute almost half of caloric intake in the diets of the population of Kenya and Tanzania, and a quarter in Uganda (see Table 1). It is much lower in Uganda, the poorest of the three countries in GDP per capita terms, because Ugandans' diet is more diversified with more than half of calories coming from fruits and vegetables, plantains, cassava and sweet potatoes; this compares to 11% for Kenya and 24% for Tanzania. Anecdotal indications from the stakeholders suggest, however, that the proportion of starchy roots has been increasing in Kenya and Tanzania as farmers plant more 'traditional' crops in response to the perceived risks associated with maize. Projections of demand for cereals and staple food crops for 2015 and 2030 indicate that cereals will continue to form a major part of the composition of the diet of people of East Africa.[7]

Table 1

Contribution of grains to caloric intake in EAC countries, 2007

	Kenya	**Tanzania**	**Uganda**
Total food supply (kcal/capita/day) Of which (%)	**2089**	**2032**	**2211**
GRAINS			
Maize	33	26	9
Wheat	9	6	4
Rice	3	10	2
Sorghum	1	4	2
Other grains	1	1	5
Total	**48**	**47**	**23**
NON GRAINS	**52**	**53**	**77**
Plantains	2	1	16
Cassava	1	12	10
Sweet potatoes	2	4	9
Fruits and vegetables	6	7	18

Source: calculated from FAO Statistics, most recent available food balance sheets

[6] Apart from the introductory section and the trade policies/institutions sections, this chapter as well as chapter 2 have been prepared by Dr. Pushpa Trivedi, Professor, Indian Institute of Technology, Mumbai with support of the data provided by Dr. Raosaheb Mohite, Asst. Vice President, FTKMC. The work was coordinated Dr. Bandi Ram Prasad, President, FTKMC. The data used for the study is from statistical information obtained from the secondary sources of FAO, World Bank and similar organizations. Some aspects of the analysis were presented in the EAGC Conference on the subject held in Nairobi, Kenya on July 7-8, 2011 by Dr. Prasad and Dr. Mohite.

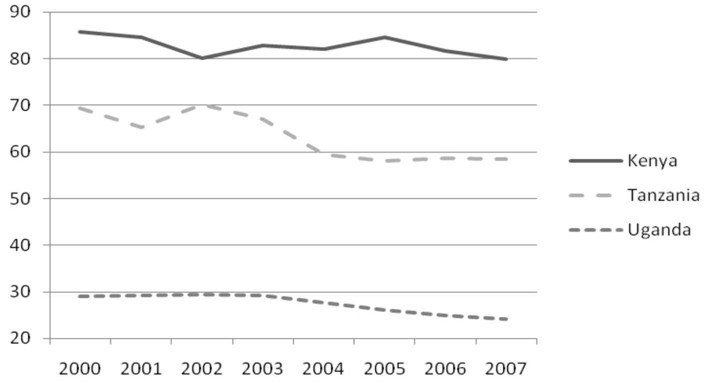
[7] Riddell, Westlake and Burke, 2006.

In all three countries, maize is the most important grain. In 2007 (the latest year for which data are available), cereals supply in Kenya was 120 kg per capita; in Tanzania, 106 kg; and in Uganda, 61 kg. Maize accounted for respectively 67 per cent, 58 per cent and 39 per cent of total cereals supply (see Annex 1).

Per capita maize supply fluctuates somewhat from year to year, as figure 1 shows, with year-to-year changes generally below 5 per cent in Kenya, but frequently in the 5-10 per cent range in Tanzania and Uganda. The figure also shows a declining trend of maize supply from 2000 to 2007.

Figure 1

Per capita maize supply quantity (kg/capita/year)

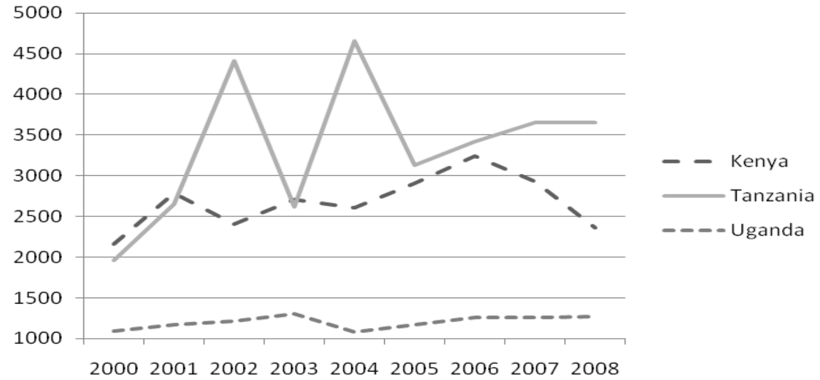


Source: FAOSTAT Agriculture

But these fluctuations in per capita supply are relatively modest when compared to fluctuations in national production. As figure 2 shows, year-to-year changes of more than 10 per cent are common in Kenya; and Tanzania exhibits even greater volatility in production (the coefficient of variation of maize production in Kenya, Tanzania and Uganda is respectively 12, 26 and 6%; for the aggregate production of the three countries, it is 13%). Production volumes in the three countries are largely uncorrelated: the correlation coefficient for the 2000-2008 period is only 9% between Kenya and Tanzania, close to zero between Tanzania and Uganda, and 38% between Kenya and Uganda.

Figure 2

Maize production (000 tons)



Source: FAOSTAT Agriculture

International trade in maize is therefore important in these countries to help level out year-to-year fluctuations. As table 2 shows, Kenya was in many years a major net importer (on average, in the years up to 2008, its net maize imports equaled almost 9 per cent of its production). According to the official trade data[8], the average imports of Kenya from 1980 to 1992 (period I) were about 18 thousand tons per year. This figure shot up to about 218 thousand tons per year during the period 1993 to 2008 (period II).[9] Tanzania is in some years a small exporter, but in others a large importer. The net import of maize in Tanzania during period I was about 75 thousand tons per year and declined to about 50 thousand tons per year in period II. Uganda has been a net exporter of maize; maize is often the cash crop for farmers whose main food crop are bananas. The net export of Uganda during period I was about 3.4 thousand tons per year and it rose to about 13 thousand tons per year during period II.

Figure 3 describes the maize trade flows in the region (Annex 3 gives a more detailed picture).

Table 2

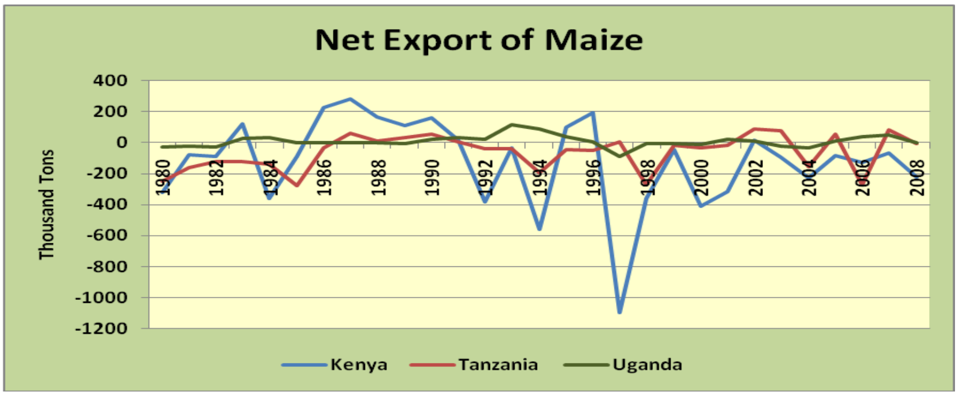
Net maize trade (net balance –imports minus exports–, '000 tons), 2000-2008

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Kenya	410	318	-16	73	242	112	130	95	223	1503
Tanzania	50	65	-74	-81	167	-46	280	-69	8	3
Uganda	10	-24	-14	48	64	-11	-58	-64	-2	-44

Source: Calculated from FAOSTAT data. Informal trade is not included.

Figure 3

Net Exports of Maize, 1980-2008

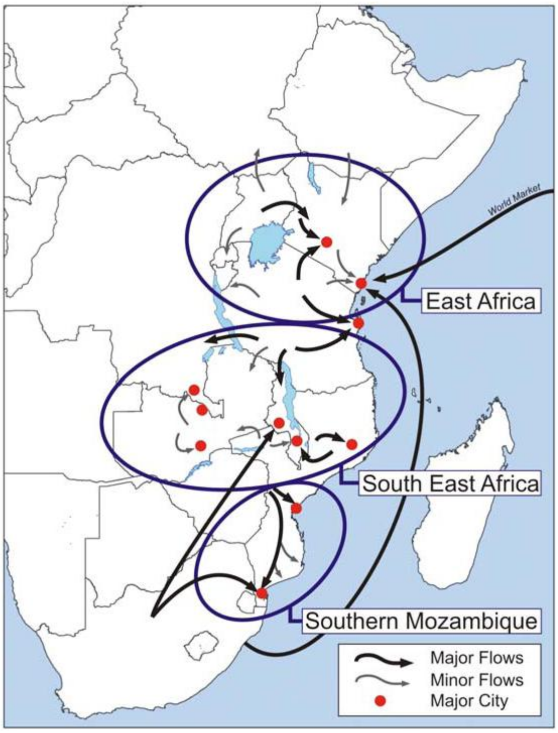


Source: Calculated from FAOSTAT data. Informal trade is not included.

[8] Informal trade adds to Uganda's and Tanzania's export numbers, and to Kenya's imports.

[9] There was a spike in nominal price of maize in Kenya in 1992. Given the importance of maize in Kenya, we refer to the period up to 1992 as period I and period 1992 to 2008 as period II. For sake of comparison, we use this periodization for other countries too.

Figure 4
Regional maize flows in the ESA region



Source: http://www.fews.net

It can also be observed that in the period covered in table 2 (2000-2008), there were only two years when all countries were net importers, and one year when all three were net exporters. While the role of other markets within the region (Rwanda, Burundi, South Sudan, Ethiopia, DRC) should not be overlooked, this suggests that a regional grain market, with free maize trade between Kenya, Tanzania and Uganda, will help mitigate national supply/demand imbalances.[10] Informal trade (which is estimated to account for at least 60 per cent of regional trade in staple grains in East Africa[11]) plays a positive role in this regard; but trade policies do not yet reflect a regional vision. Although COMESA and EAC trade agreements are in place which should provide for a free flow of maize within the region, governments tend to act nationalistically when they perceive a threat of a local maize shortage.

[10] Karugia et al., 2009a, find that eliminating non-tariff barriers to cross-border maize trade between Kenya, Tanzania and Uganda would have a significant positive welfare effect. However, gains are unequally distributed, with farmers in Uganda the largest beneficiaries, and farmers in Kenya and Tanzania (whose maize prices fall), as well as consumers in Uganda (who pay higher maize prices), suffering welfare losses in a better integrated market. This is a controversial finding, as many market observers believe Tanzanian farmers would be large beneficiaries of the liberalization of maize trade.

[11] Karugia et al., 2009b.

1.1 Maize economy of Kenya

Maize occupies a central position in the diet of Kenyan people. In recent times, the volatility of maize prices has been a cause for concern, as it adversely affects both the producers and consumers. Producers are also affected by weather-induced volatility in production. If prices and production vary in opposite directions, then to the volatility in incomes is reduced at least to some extent. The price of maize depends on both real factors (such as, production, which in turn depends on the area harvested and the yield) and on monetary factors which operate at the macro level. In view of this, the real side of the maize economy in Kenya is presented first, followed by a discussion of macro factors.

Harvested area, yield and production of maize

Maize production in Kenya in 2009 was 1.5 times that of 1980. Most of the growth came from a growth in acreage: in 2009, the area harvested under maize was 1.4 times that of 1980. The population of Kenya multiplied by almost 2.45 times over this period and hence, the per capita production of maize in Kenya witnessed a substantial fall from 0.10 tons (1980) to 0.061 tons (2009). Table 3 presents the summary statistics for the real variables pertaining to maize in Kenya.

Table 3

Summary statistics of area, yield and production of maize (1980 to 2008)

Variable	Unit of measurement	Mean	Std. Dev.	Min	Max	CV
Area	Hectares (thousand)	1470	200	985	1888.2	13.6
Yield	Hg/Ha	16706	2206	12000	20711	13.2
Production	Tons (thousand)	2448	402	1422	3247	16.4
Per capita production	Tons/person	0.094	0.023	0.061	0.143	24.3

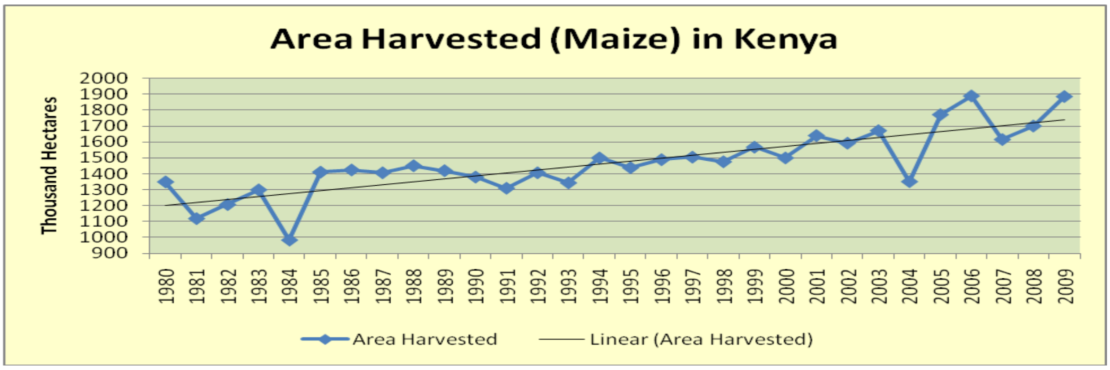
Source: Calculations based on data from FAOSTAT

It can be seen from Table 3 that the fluctuations in maize production and per capita production have been higher than those witnessed in the area and yield of maize. The fluctuation in maize production and per capita production, *inter alia*[12], are bound to cause fluctuations in maize prices.

Figures 5 to 8 give a synoptic view of the yearly movements of these variables. Both the area harvested and production of maize in Kenya have witnessed a rising trend over the period of 1980 to 2009. However, the yield and per capita production of maize have witnessed a declining trend over this period. The latter has witnessed the sharpest decline.

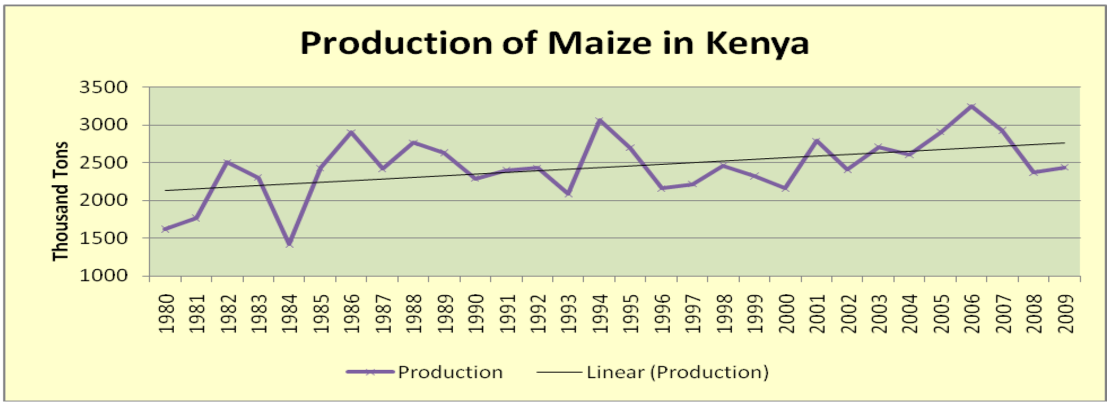
[12] The other factors would be the liquidity conditions in the economy and the intervention policy of the government in the maize market.

Figure 5
Harvested area in maize in Kenya



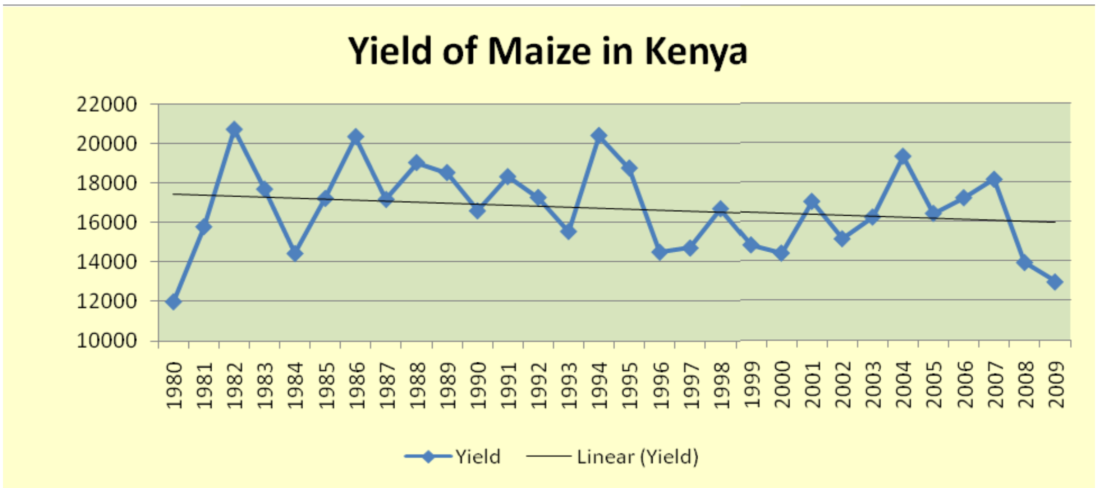
Source: Based on data from FAOSTAT.

Figure 6
Production of maize in Kenya



Source: Based on data from FAOSTAT.

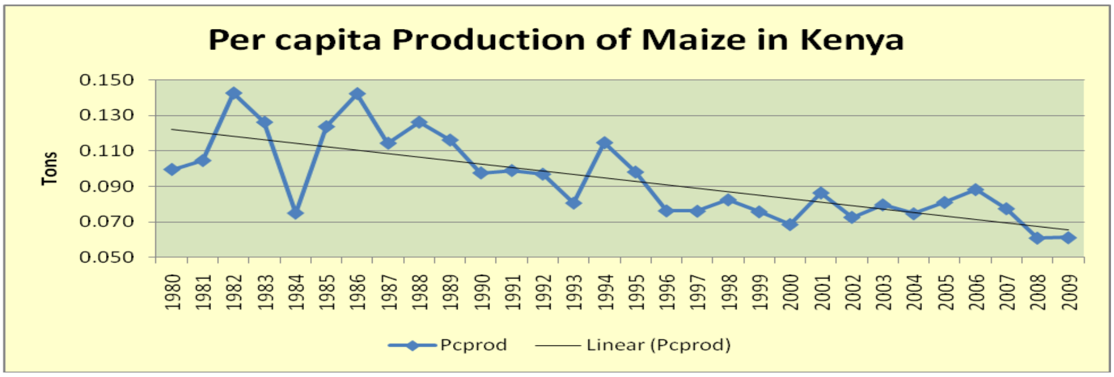
Figure 7
Yield of maize in Kenya (hg/ha)



Source: Based on data from FAOSTAT.

Figure 8

Per capita production of maize in Kenya



Note: Based on data from FAOSTAT

Average rate of growth in area harvested, yield and production of maize

Table 4 provides the average rates of growth and the coefficient of variation in the growth rates of these variables over the period 1980 to 2009.

Table 4

Average growth rates of area, yield and production of maize

	Average Growth Rates (% p.a.)			Coefficient of Variation (%)		
Variable	1981-2008	1981-1992	1993-2008	1981-2008	1981-1992	1993-2008
Harvested area under maize	1.6	1.5	1.8	818.3	1110.4	641.2
Yield of maize	1.8	4.5	-0.2	914.1	401.6	-7500.4
Production of maize	3.6	6.7	1.3	635.3	423.1	1451.8
Per capita Production of Maize	0.4	2.9	-1.5	5265.6	932.5	-1212.2

Source: Calculations based on data from FAOSTAT.

It can be seen from Table 4 that from 1981 to 2008, the average rates of growth of production of maize was about 3.6 percent per annum (pcpa, henceforth), and of this, about half was due to increase in area and remaining half due to increase in yield of maize. However, the average rate of growth of per capita production of maize during this period was only 0.4 pcpa. There was sharp decline in the rate of growth of production of maize in Kenya during the post 1992 period (period II) as compared to the pre-1992 period (period I). It declined from about 6.7 pcpa from the period I to about 1.3 pcpa during period II. This decline in the rate of growth of production in maize was entirely due to a decline in the yield of maize which fell from 4.5 pcpa (period I) to -0.2 pcpa (period II).

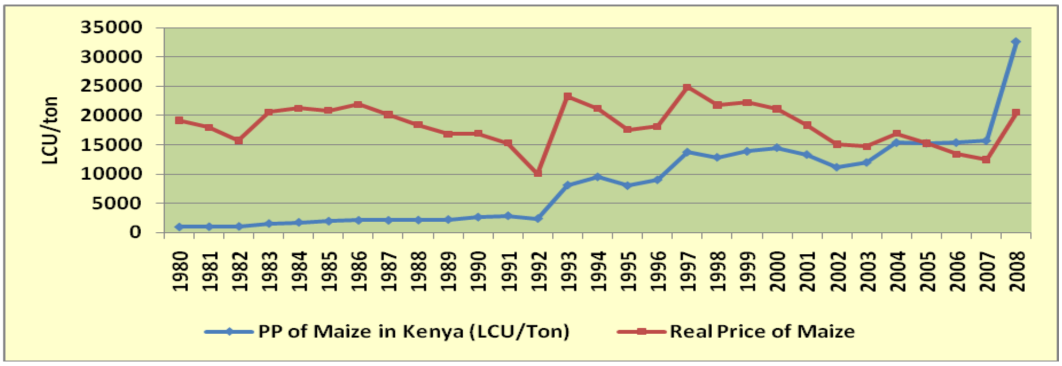
Movement of maize prices

When discussing the movement of maize prices in Kenya, a distinction has to be drawn between the nominal and real price of maize. The nominal price of maize is defined here as the local currency price of maize per ton, deflated it by the Consumer Price Index (CPI) for obtaining the real price[13].

It can be noted from Figure 9 that the rise in nominal price of maize in Kenya has been rather sharp after 1992 as compared to the pre-1992 period. The price rise in average nominal price is more than seven-fold in the latter period as compared with the former. However, the average real price of maize in the post-1992 period is just 1.03 times of that during period I (see Table 5).

Figure 9

Nominal and real price of maize in Kenya



Source: Based on data from FAOSTAT and IFS online. Real Price of maize has been obtained by deflating the nominal price in Nairobi by the CPI. CPI for Kenya is at base 2005= 100.

Table 5

Summary of maize price movement, 1980 to 2008

Variable	Period	Mean	Std. Dev.	Min	Max	CV
Real Price	1980-2008	18341.5	3455.0	10036.8	24846.7	18.84
Nominal Price		8442.4	7308.6	954.0	32581.0	86.57
Real Price	1980-1992	18084.3	3222.5	10036.8	21871.4	17.82
Nominal Price		1900.7	616.4	954.0	2870.0	32.43
Real Price	1993-2008	18550.6	3724.3	12469.1	24846.7	20.08
Nominal Price		13757.6	5672.9	8000.0	32581.0	41.23

Source: Calculations based on data from FAOSTAT and IFS online.

[13] This is because the price of maize may rise due to macro factors (such as, increase in liquidity) operating in the economy, besides due to a rise in demand relative to per capita production. The real price thus, tries to remove the variations in maize price on account of macro factors.

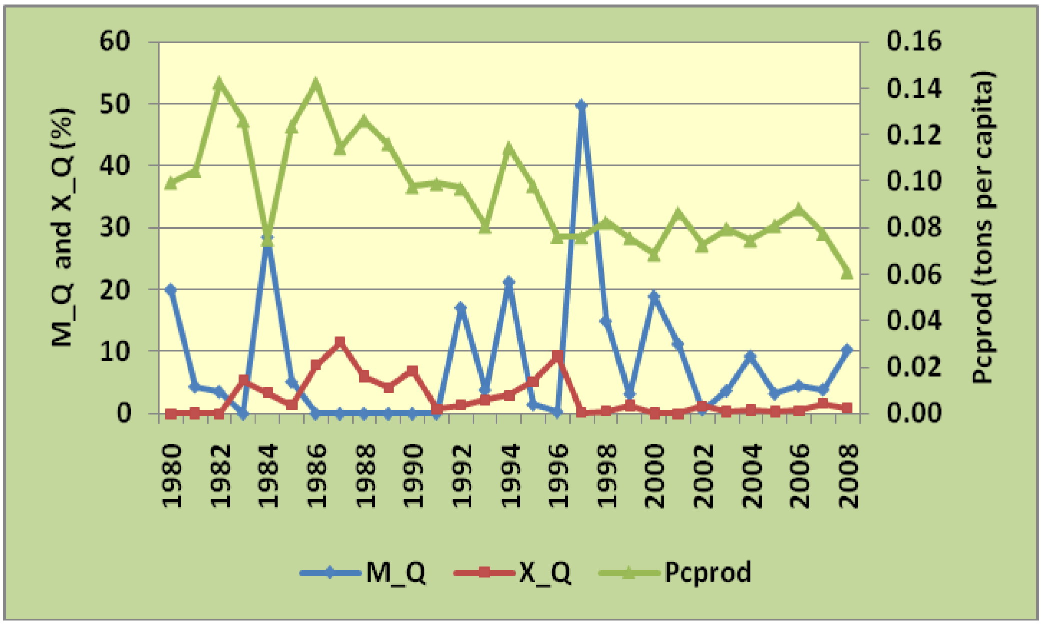
Table 6
Rates of change in real and nominal prices of maize

Variable	Average % Change in Maize Prices (pcpa)			Coefficient of Variation in Maize Prices (%)		
	1981-2008	1981-1992	1993-2008	1981-2008	1981-1992	1993-2008
Real Price	3.5	-4.2	9.3	898.9	-360.2	423.9
Nominal Price	19.2	8.8	27.0	257.7	164.6	237.2

Source: Calculations based on data from FAOSTAT and IFS online.

Though the average changes in real price of maize are not very different from period I to period II, this is due to aggregation. However, as can be seen from Table 6, there has been increase in the rate of change in maize prices, both real and nominal in Kenya during period II, as compared with period I.

Figure 10
Imports and exports and per capita production of maize in Kenya



Note: M_Q and X_Q denote the ratio of imports and exports to production (%), respectively.
Source: Calculations based on data from FAOSTAT.

The correlation coefficient of the import to production ratio (M_Q) and per capita production for the period 1980 to 2008 is -0.33 and that of the exports to production ratio (X_Q) and per capita production is 0.38 – which simply indicates that Kenya imports maize in deficit production years and exports maize in surplus years. In fact, in 1997 the ratio of import of maize to domestic production was as high as 50 percent. In five years it was about one-fifth of the domestic production.

Kenyan maize trade policies and institutions

Kenya is ordinarily dependent on a small flow of maize - formal and informal - from Uganda, but otherwise wants to keep out imports from outside the region to put a floor under local prices. For this reason, Kenya generally maintains high external tariffs on maize flows from outside the region (of up to 50%). But in case of droughts or other supply shocks (which have occurred quite frequently in past years), it needs to bring in maize from outside the region (South Africa, or even the USA). This may be accompanied by a slashing of import tariffs – on 27 April 2011, for example, all import duties for maize and wheat were removed. This has been a major cause of market uncertainty in recent years. Whenever such a decision is taken, it leads to a sizable fall in market prices. This uncertainty has impeded farmers' production incentives, and because it makes maize storage very risky, has dampened traders' willingness to maintain seasonal maize storage. As extensively documented and discussed in Jayne and Tschirley (2009b) it also deters traders/importers – whether from within or outside the region - from acting early to avert massive shortages, thus exacerbating the shortages and price increases, with prices heading above import parity levels in the long term. This reduces the maize sector's resilience to shocks, and the result, in turn, can be that prices exceed import parity for a sustained period of time.

Kenya has a marketing board, the National Cereals & Produce Board (NCPB), which has the twin mission of price stabilization and maintaining a strategic reserve. In times of low prices, it attempts to boost producer prices by announcing a buy price above market prices; and when prices are "too high", it can sell its stocks into the market. According to the NCPB, it has only a small impact on prices as its purchases are as little as 2-3% of total production (albeit up to 7-8% in some years). Yet research indicates that NCPB can have a significant impact on prices[14]; and most stakeholders agree that the NCPB price is a major signal for producers, who take decisions to sell or store, and in negotiating with traders/millers on the basis of the NCPB price.

According to private sector stakeholders and researchers, including research carried out by this project team, there are a number of major issues with the NCPB's modus operandi:

i. the NCPB price announcements and sales are a major source of uncertainty for the market, and prevent millers in particular from taking forward positions (almost completely inhibiting any possibility of contracting flexibility beyond spot market pricing);

ii. NCPB itself appears in many ways dysfunctional – for example, it can take 5-6 months to release payments to producers, who are as a result reluctant to supply NCPB;

iii. NCPB buy prices are often lower than its stabilization function would indicate – the reasons are that it is under-funded, and to achieve targets for holding reserves, it may seek to keep prices low so as to be able to afford to buy more;

iv. Most NCPB depots are located in surplus areas and it is a struggle to redistribute maize to deficit areas (exacerbated by slow turnaround for decision-making at both NCPB and the political level);

v. NCPB does not appear to be trusted by farmers, millers or traders.

[14] Jayne, Myers and Nyoro, 2008, find that in the period from 1990 to 2004, NCPB's market interventions had raised prices for farmers in surplus years, and reduced prices for consumers in deficit years.

There are a number of priority actions that would improve the performance of Kenya's maize sector. The government and donor agencies should encourage investments in storage, transportation and post-harvest handling. The government has to make efforts to bridging the trust gap between itself, NCPB and the private sector. This can be done by depoliticizing decision-making on maize market interventions, reforming NCPB price-setting, procurement and distribution operations to make them more market-friendly, and expediting the NCPB payments cycle.

1.2 Maize economy of Tanzania

Harvested area, yield and production of maize in Tanzania

Maize production in Tanzania in 2009 was 1.93 times that of 1980. The area harvested under maize was 2.12 times as compared to 1980. The population of Tanzania multiplied by almost 2.34 times over this period and hence, the per capita production of maize in Tanzania witnessed a substantial fall from 0.09 tons (1980) to 0.077 tons (2009). Table 7 presents the summary statistics for the real variables pertaining to maize in Tanzania.

Table 7

Summary statistics of area, yield and production of maize (1980 to 2008)

Variable	Unit of measurement	Mean	Std. Dev.	Min	Max	CV
Area	Hectares (thousand)	1864592	699659	845950	3462540	37.5
Yield	Hg/Ha	14870	5041	7549	31358	33.9
Production	Tons (thousand)	2590965	790522	1485800	4651370	30.5
Per capita production	Tons/person	0.0876	0.0175	0.0511	0.1269	20.0

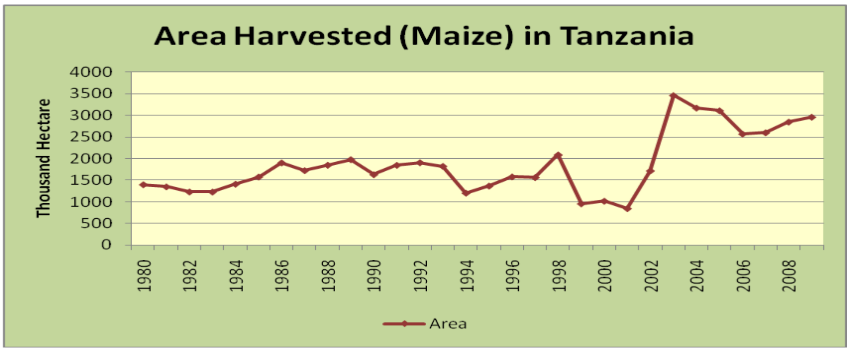
Source: Calculations based on data from FAOSTAT.

It can be seen from Table 7 that the fluctuations in maize production and per capita production have been lower than those witnessed in the area and yield of maize, unlike in the case of Kenya. The fluctuation in maize production and per capita production, *inter alia*[15], are bound to cause fluctuations in maize prices.

Figures 11 to 14 give a synoptic view of the yearly movements of these variables. The area harvested under maize in Tanzania registered a sharp increase in 2002-3 years and declined thereafter. The yield of maize in Tanzania registered a sharp decline in the recent years after a period of high yield in the late nineties. The absolute production of maize in Tanzania has witnessed a rising trend, albeit with fluctuations. Moreover, the absolute production of maize in Tanzania has been lower in recent years as compared to the early years of the last decade.

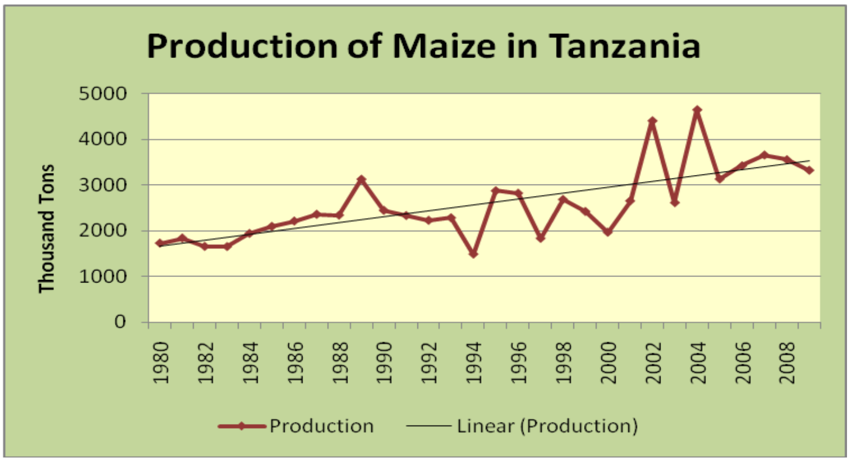
[15] The other factors would be the liquidity conditions in the economy and the intervention policy of the government in the maize market.

Figure 11
Area harvested (maize) in Tanzania



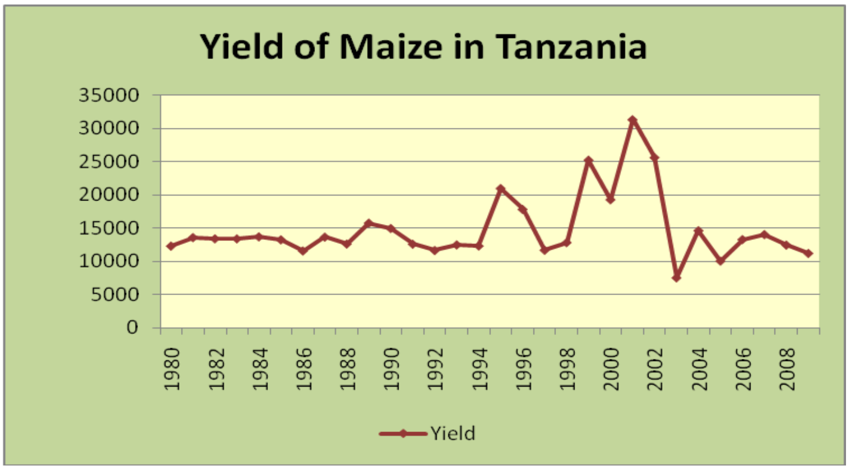
Source: Based on data from FAOSTAT.

Figure 12
Production of maize in Tanzania



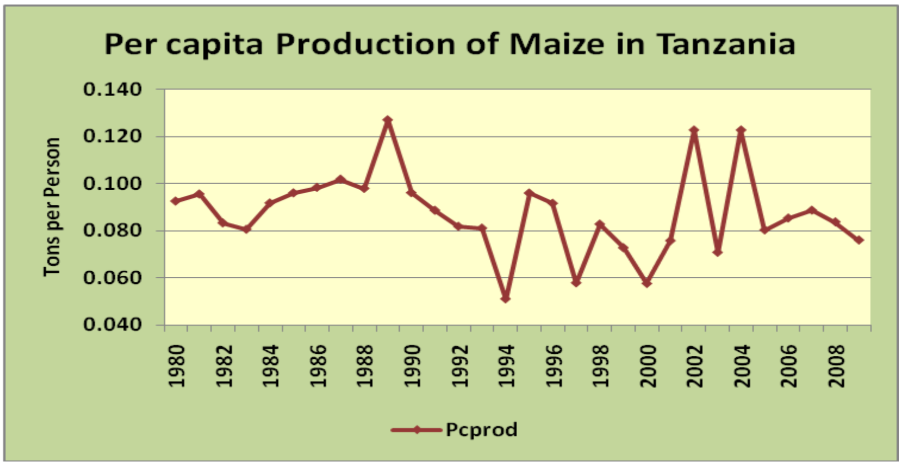
Source: Based on data from FAOSTAT.

Figure 13
Yield of maize in Tanzania (hg/ha)



Source: Based on data from FAOSTAT.

Figure 14
Per capita production of maize in Tanzania



Source: Based on data from FAOSTAT.

Average rate of growth in area harvested, yield and production of maize in Tanzania

In Table 8, the average rates of growth and the coefficient of variation in the growth rates of these variables over the period 1980 to 2008 are provided.

Table 8
Summary of average rates of growth (1980 – 2008)

	Average Growth Rates (% p.a.)			Coefficient of Variation (%)		
Variable	1981-2008	1981-1992	1993-2008	1981-2008	1981-1992	1993-2008
Harvested area under maize	6.60	3.22	9.13	485.9	356.7	456.3
Yield of maize	6.24	0.18	10.79	594.2	6585.8	446.3
Production of maize	7.04	2.99	10.07	467.3	465.7	419.1
Per capita Production of Maize	3.95	-0.19	7.06	810.1	-7069.8	581.7

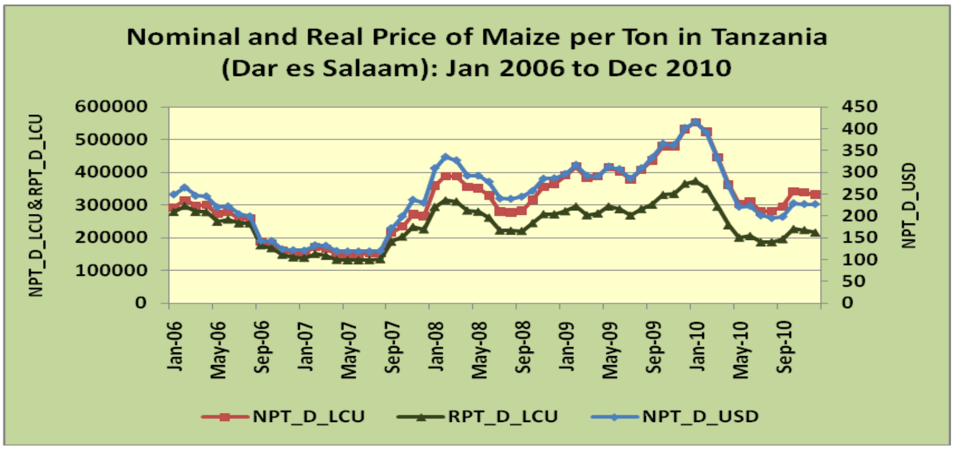
Source: Calculations based on data from FAOSTAT.

Movement of maize prices

In the absence of availability of yearly data on maize prices in Tanzania, the monthly maize prices in one of the main markets in Tanzania, viz., Dar-es-Salaam, are given here (see Figure 15). A seasonal variation in maize prices can be observed in this figure.

Figure 15

Nominal and real prices for maize – Dar-es-Salaam, Tanzania



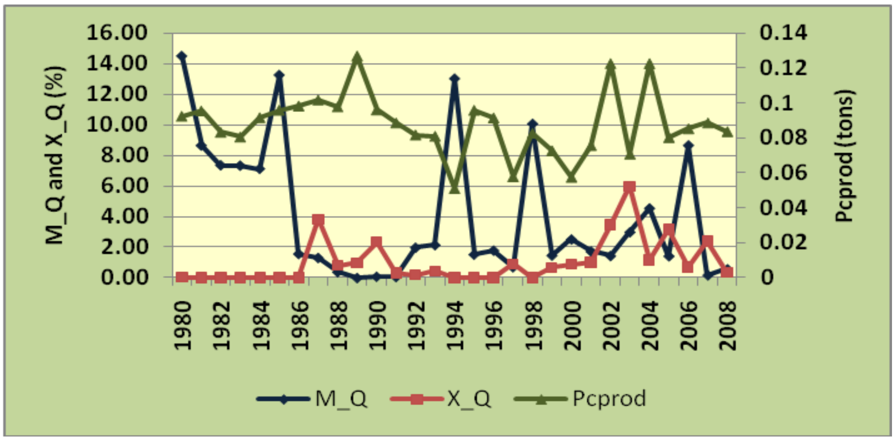
Source: Calculations based on data from FAOSTAT and IFS online. NPT_D_LCU denotes nominal price of maize in Tanzania (Dar-es-Salaam market) in local currency units. RPT_D_LCU denotes real price of maize in Tanzania (Dar-es-Salaam market) in local currency units. RPT_D_LCU is derived by deflating NPT_D_LCU by the CPI (base 2005 = 100). NPT_D_USD denotes nominal price of maize in Tanzania (Dar-es-Salaam market) in US dollar.

It can be seen from Figure 15 that it is not only seasonality that has led to fluctuations in prices. If the peaks in prices (which typically occur in January) are compared, each successive peak seems to be higher, except for 2009. Similarly troughs in prices have also been higher. The volatility does not seem to be caused by exchange rates as the prices in the local currency terms and in US dollar terms have been moving in the same direction.

It can be seen from Figure 16 that Tanzania has exported maize, mainly during the latter half of the nineties and in the recent years, depending on the domestic availability. There have been sharp spikes in imports in relation to production, across the decades. The spikes in imports can be explained mainly due to supply side factors.

Figure 16

Import and exports and per capita production of maize in Tanzania



Source: Calculations based on data from FAOSTAT. M_Q and X_Q denote the ratio of imports and exports to production (%), respectively. Pcprod is per capita production.

Tanzanian maize price policies and institutions

At a national level, Tanzania is ordinarily self-sufficient in maize, its key food staple. More than 80 per cent of farmers grow maize. However, there are surplus and deficit areas. Tanzania domestic market integration is poor, mainly the result of deficient transportation infrastructure connecting the deficit areas with the production centers. The links between the country's maize market and that of neighboring countries mainly pass through informal trade[16]; some parts of the country are well connected (e.g., Arusha with Nairobi; North West Tanzania with Rwanda and Uganda; South Tanzania with Zambia, Malawi and Mozambique), others less so. The situation in deficit areas, then, can drive an instinctive response of the government to impose an export ban 'to feed our own children before we feed those of our neighbors'. Such bans never reach the intended objective of keeping the maize inside Tanzania, first, because of the country's porous borders and second, because of dysfunctional distribution from surplus to deficit areas.

Tanzania has a National Food Reserve Agency (NFRA), but it deals only in small volumes and has much less impact than NCPB in Kenya. Its mission is to guarantee national food security by procuring and reserving strategic food stocks in an efficient and cost effective manner.[17] It has a mandate to store 150,000 tons (enough for three months of consumption), with a third of its stock rotated each year. NFRA may sell to the Disaster Management Unit of the Prime Minister's Office, but during times of food shortages, some of its stock is sold to private traders at subsidized prices so that traders can sell it to final consumers at lower prices. NFRA has been undergoing various reforms which seem to have degraded its operational capability.

Tanzania's imports and exports are mostly within the region. If there are no export bans, maize trade is often seasonal, with imports occurring in the months leading up to the main harvest (March, April, and May) and exports occurring during the harvest months (June, July, and August).[18]

Private sector stakeholders and researchers consider Tanzania's policies of export bans as a major hindrance to efficient trade, for two main reasons:

(i) it is not always clear when the export bans are in place and when they are not. Export bans come and go, and even the border/customs authorities are not always in the loop on such things, meaning there may be problems at the border from uninformed officials; and

(ii) several 'insider' traders use their 'mastery of the system' to create an oligopoly on export opportunities.

In order to improve the performance of the maize sector, the government should consider the opportunities for reaping value from regional export opportunities rather than protecting the domestic market. Industry stakeholders are of the view that the producer disincentives that have resulted from past export bans, crop taxes and heavy bureaucracy need to be actively countered.[19] The government, then, needs to visibly distance itself from an interventionist mindset, and it needs to ensure that its

[16] The informal character of the maize trade does cause efficiency losses. Much of it is through bicycle agents which bring small volumes across the border which then are aggregated for further domestic transport.

[17] Mukwenda, 2010.

[18] Minot, 2010a.

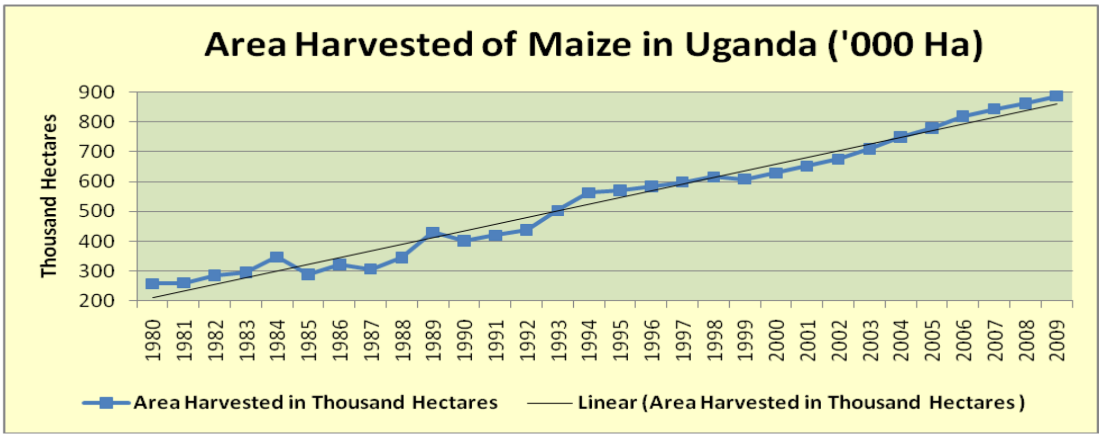
[19] Removing non-tariff barriers to trade, however, cannot be the sole or even main component of a policy to stimulate maize production in Tanzania. Policies to improve productivity have to accompany trade liberalization policies.

officials at the local levels, including the border posts, are fully aware of this policy shift. There are good opportunities to expand production in surplus areas to serve lucrative cross-border opportunities – and in particular, through spatial integration with Kenya, Malawi, Mozambique, Uganda and Zambia – building on infrastructure initiatives such as the Southern Agricultural Growth Corridor of Tanzania (SAGCOT), backed by trade agreements.

1.3 Maize economy of Uganda

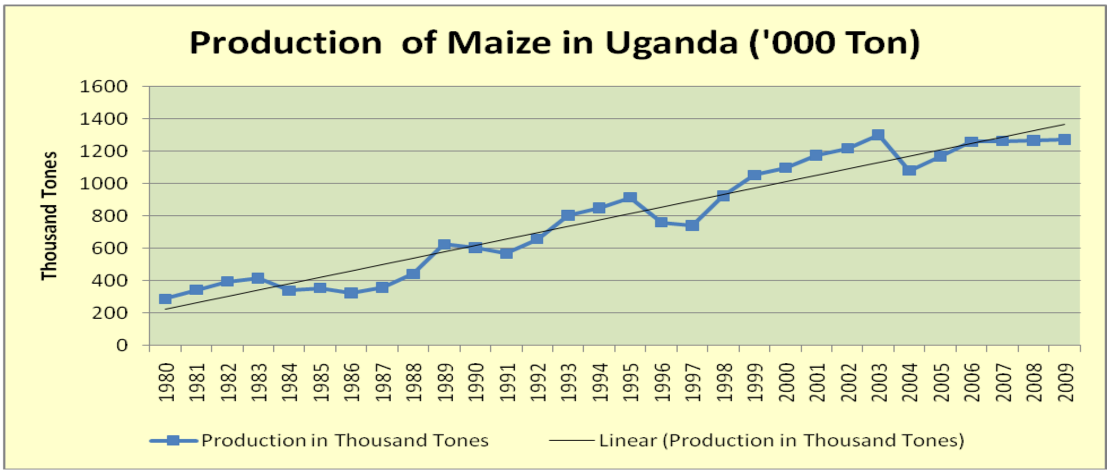
Maize is the third item in the staple food of Uganda, as mentioned earlier. Plantains and cassava, the main food crops are mainly produced and consumed within the country due to low value-bulk ratio, the perishability of plantains and the high water content of cassava. Compared to these two staples, maize is a readily exportable crop. Uganda is a net exporter of maize primarily to Kenya. Maize production in Uganda multiplied by 4.4 times, area harvested under by 3.4 times and population by 2.6 times in 2009 as compared to that in 1980 (see Figures 17 to 20 and Table 9). Thus, per capita production in Uganda has risen over time and this also explains the export of maize by Uganda.

Figure 17
Area harvested of maize in Uganda in '000 Ha (1980 – 2009)



Source: Calculations based on data from FAOSTAT.

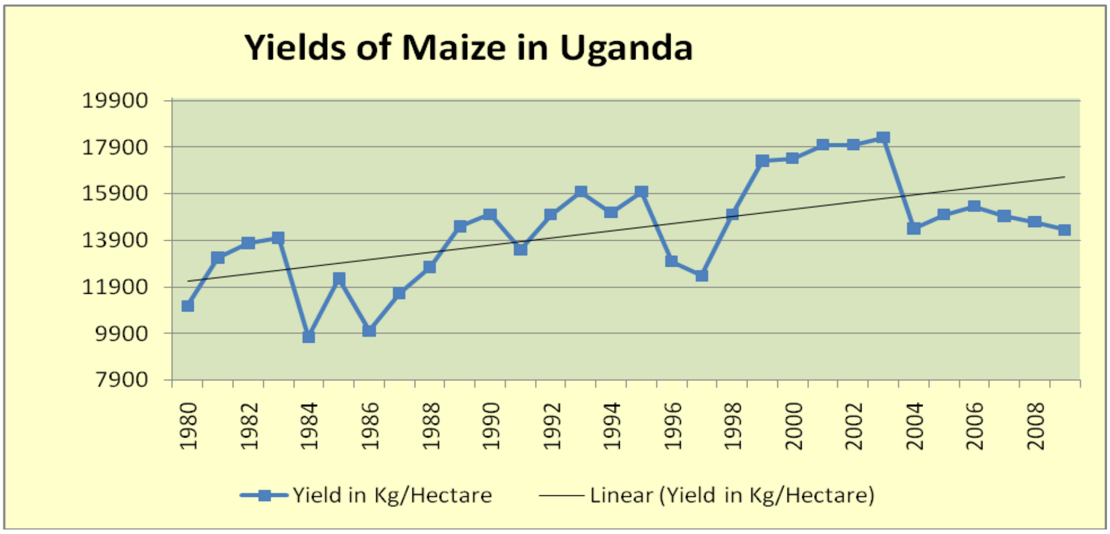
Figure 18
Production of maize in Uganda in '000 Ha (1980 – 2009)



Source: Calculations based on data from FAOSTAT.

Figure 18

Yields of maize in Uganda in hg/ha (1980 – 2009)



Source: Calculations based on data from FAOSTAT.

Table 9

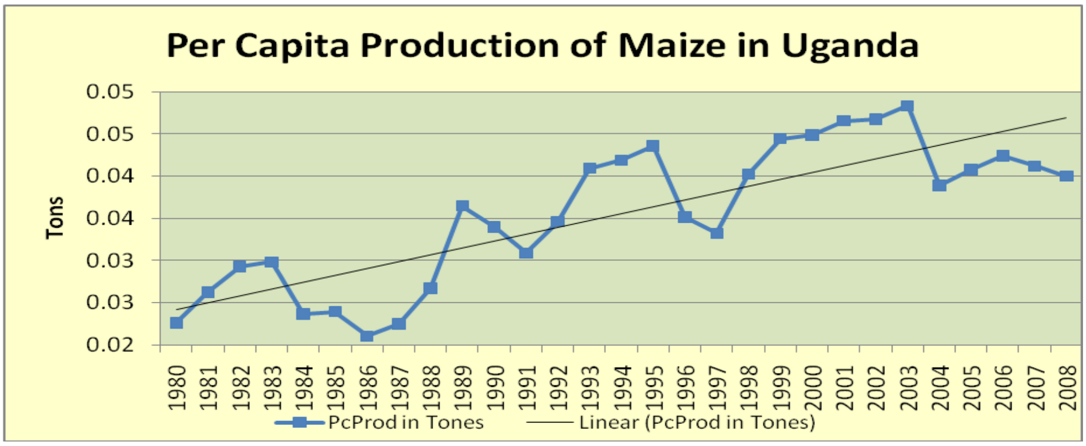
Summary statistics of area, yield and production of maize (1980 to 2009)

Variable	Unit of measurement	Mean	Std. Dev.	Min	Max	CV
Area	Hectares (thousand)	535.0	200.1	258.0	887.0	37.4
Yield	Hg/Ha	14388.8	2222.1	9740.0	18309.0	15.4
Production	Tons (thousand)	794.4	358.6	286.0	13000.0	45.1
Pcprod	Tons/person	0.036	0.008	0.021	0.048	23.6

Source: Calculations based on data from FAOSTAT.

Figure 19

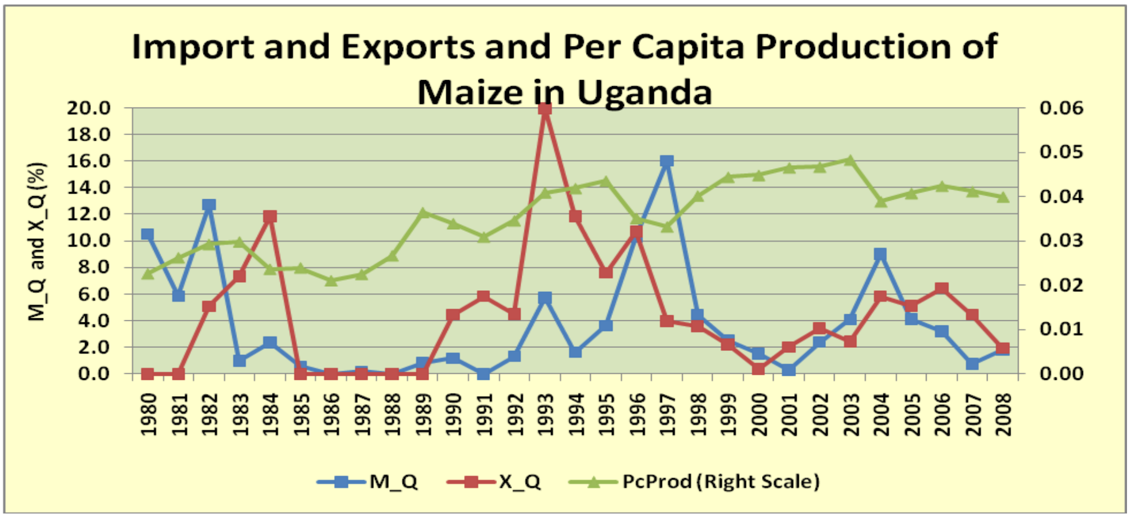
Per capita production of maize in Uganda (in Tons /annum)



Source: Calculations based on data from FAOSTAT.

Figure 20

Imports, exports and per capita production of maize in Uganda (1980 – 2009)



Source: Calculations based on data from FAOSTAT. M_Q and X_Q denote the ratio of imports and exports to production (%), respectively.

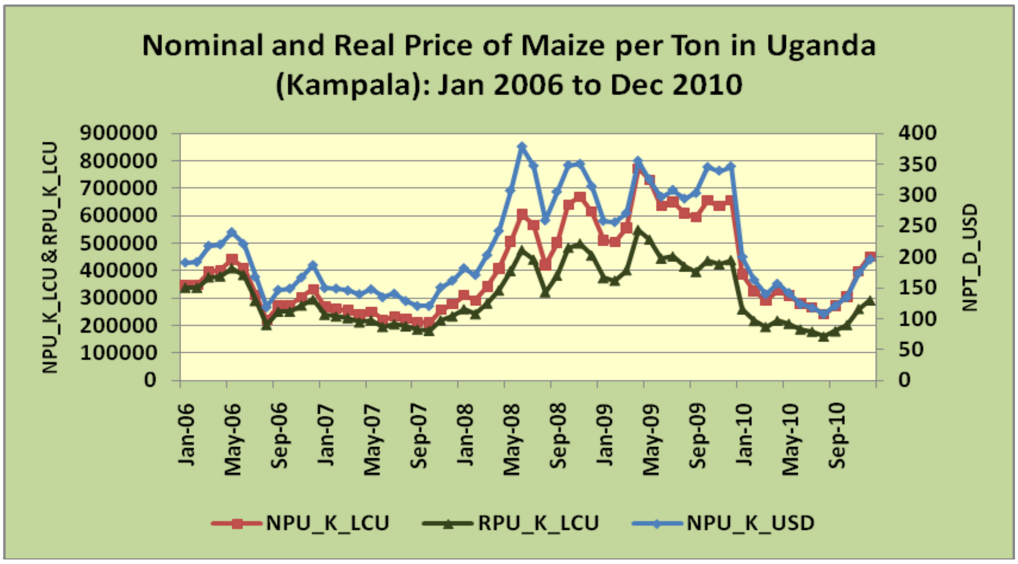
Table 10

Average growth rates of area, yield and production of maize in Uganda

	Average Growth Rates (% p.a.)			Coefficient of Variation (%)		
Variable	1981-2008	1981-1992	1993-2008	1981-2008	1981-1992	1993-2008
Harvested area under maize	4.7	5.1	4.4	165.7	221.7	89.0
Yield of maize	1.9	3.9	0.4	697.8	422.3	2596.4
Production of maize	6.3	8.3	4.8	214.4	197.0	234.3
Per capita Production of Maize	2.8	4.7	1.5	455.6	335.9	734.3

Figure 21

Nominal & real prices of maize in Uganda (Kampala) (Jan 2006–Dec 2010)



Source: Calculations based on data from FAOSTAT and IFS online. NPU_K_LCU denotes nominal price of maize in Uganda (Kampala market) in local currency units. RPU_K_LCU denotes real price of maize in Uganda (Kampala market) in local currency units. RUT_K_LCU is derived by deflating NPU_K_LCU by the CPI (base 2005 = 100). NPU_K_USD denotes nominal price of maize in Uganda (Kampala market) in US dollar.

It can be seen from Figure 21 that like Tanzania, it is not only seasonality that has led to fluctuations in prices. From May 2008 to Jan 2010 price of maize in Uganda has been rather high. Moreover, the volatility does not seem to be caused by exchange rates as the prices in the local currency terms and in US dollar terms have been moving in the same direction.

Ugandan maize price policies and institutions

Maize is not the key staple in Uganda**.** Nevertheless, it is the most widely grown crop, produced by some 57% of farmers (often as a cash crop, jointly with beans).[20] Maize markets are of large importance to poor households, both rural and urban (both are net buyers of maize). According to one study, in most of Uganda, maize price increases in 2007 and 2008 (which were the spillover of Kenyan price increases) had a larger impact on pushing people into poverty than price rises of the other main staple foods combined.[21]

Uganda is a surplus maize producer, which has enabled it to pursue a liberalised market approach to the maize sector. Of the 1-1.3 million tons/year produced, a significant portion is exported to Kenya, Tanzania, Sudan, Rwanda, Burundi, Zambia and the Democratic Republic of Congo (DRC), mostly through informal channels. The largest single buyer is the World Food Program (WFP), which purchases some 150,000 to 200,000 tons, destined for food-insecure Ugandans and refugees/internally displaced persons, and for supplying Rwanda, DRC, Sudan, Ethiopia and Kenya. The country has the capacity to produce and export much more maize, but significant non-tariff trade barriers, poor infrastructure and insufficient maize trade finance facilities act as constraints.

[20] Haggblade and Dewina, 2010.

[21] Simler, 2010.

Much of Uganda's maize exports could be in value-added form. Currently, apart from the maize sold to WFP, most maize traded is of non-uniform quality and often, poorly handled. Partly as a result of this factor, Uganda's maize farmgate prices are less than half of urban traders' wholesale prices.[22] Improving the quality of the maize traded (in particular by enhancing farmers' capacity to clean and dry maize prior to delivery or storage) will improve prices and reduce physical losses in the handling of the maize. Furthermore, there are virtually no maize mills in Uganda; and those mills that exist often operate only sporadically, on the basis of WFP processing orders. There are therefore good possibilities to strengthen the milling sector. The operations of WFP can be better aligned with sector development policies, in particular by further strengthening the links between WFP and the Uganda Commodity Exchange (UCE), with the latter acting as procurement agent, enhancing market access for Ugandan farmers, improving quality control, and facilitating commodity finance via its warehouse receipt system. As of 2010, UCE's role in maize trade remained minimal, however, with only 15,000 tons of maize passing through the warehouses that it regulates.

[22] Taylor (2011). This compares with 63% for farmers in Malawi.

Chapter 2
A quantitative look at volatility, market integration and price formation

2.1 Volatility in maize prices in Kenya, Tanzania and Uganda

Volatile maize prices affect consumers by impacting their budgeted expenditure on food. And they affect the incomes of maize producers which in turn affects their consumption levels of other goods and services. One of the criticisms of the government intervention in Kenya is that the maize support prices by the Government through NCPB have resulted in an upward bias in prices of maize and are protecting the producers at the cost of consumers. Moreover, the price stabilization policy for maize in Kenya is alleged to protect basically large farmers, as small farmers are net buyers rather than net sellers of maize. This section analyzes the volatility of maize prices in the three countries.

2.2.1 Methodology adopted

Maize price data in East Africa are poor. For the analysis in this chapter, monthly prices in a number. of markets were used. Such prices are collected in more than 20 markets, but in most cases, price series are short and/or show significant gaps. For this reason, the focus has been on five markets which show relatively long price series, starting in 2006 and 2007. A larger number of observations (e.g., weekly prices) would have been preferable and would probably have given more robust results.

Volatility consists of expected fluctuations plus unpredictable fluctuations. These two components can be evaluated by measuring both unconditional and conditional volatility. The second measure strips away the predictable part of volatility and leaves just the unpredictable part.

If one believes in some form of rational expectations, then the welfare benefits of public price stabilization efforts lie in the reduction of unpredictable fluctuations only – in other words, discussing price stabilization efforts in the context of unconditional volatility (as policy makers are wont to do) may grossly over-estimate the benefits of such efforts. This is well-argued in Moledina et al., 2004:

> "While this evidence does not suggest that farmers exploit all of the information available in forming rational expectations, it nevertheless suggests some rationality in basing the expectation of future outcomes on historical evidence. Thus we proceed with the hypothesis that producers are rational in the sense that their expectations of price levels and volatility reflect some form of adaptive or rational expectations: that at any point in time, the producer's expectation of the distribution of future price is a function of past realizations.
>
> Previous studies have typically measured commodity price uncertainty (volatility) using the unconditional standard deviation or the coefficient of variation. Implicit in this measurement is the idea that past realizations of price and volatility have no bearing on current or future realizations. However, it seems reasonable to expect that producers can distinguish regular features in a price process such as seasonal fluctuations and the ex-ante knowledge of the conditional distribution of commodity prices. On the basis of this information, producers generate probabilistic assessments of predictable and unpredictable elements in a price process. The unconditional standard deviation of course does not distinguish between these two components of a price series, and thus overstates the degree of uncertainty."

The methodology to measure these two forms of volatility is as follows:

(1) **Unconditional volatility (Standard deviation and coefficient of variation**)

Price instability can be defined as the unconditional volatility of prices, often measured as a standard deviation or coefficient of variation.[23] In order to estimate the unconditional volatility, we have considered volatility in the trend as well as in the cyclical component of the price series. To extract the trend component we have used the Hodrick-Prescott (HP, henceforth) filter which is the most popular approach to decompose a series into trend and cyclical components.

(2) **Conditional volatility**

A part of price volatility may be predictable and essential for markets to function. Though the unconditional CV (i.e., the standard deviation divided by the mean) is a meaningful measure of price volatility, it does not measure the volatility in prices that is predictable or what is termed as the conditional volatility.[24] Conditional volatility or conditional variance of a time-series can be measured as follows. First one has to ensure that the series is stationary of I(0) series and does not contain unit root. Therefore, the unit root test has to be performed on the concerned series and then, based on autocorrelation function one can identify the data generating process or identify the lag orders p and q for the autoregressive and moving average terms of the ARIMA series. The unit root in the log transformed raw price series turns out to be I(1) therefore the first difference of the log transformed series is used, which represents the inflation in the price series. After this, one can specify the conditional mean equation. The conditional volatility is then estimated using the squared residuals from the conditional mean equation.

To measure conditional volatility, one needs to adapt a dynamic model of price volatility. This is done using ARCH or GARCH models.[25] In the ARCH (Autoregressive Conditional Heterokedastic Model) class of models, the strategy is to forecast the conditional variance using only the lag values of the estimated residuals, whereas, in the GARCH (Generalized Autoregressive Conditional Heterokedastic Model) class of models both autoregressive as well as moving average terms are present in the conditional variance equation. The benefit of the GARCH is that a higher order ARCH model has a more parsimonious GARCH representation which is much easier to identify and estimate.

The GARCH model allows the conditional variance to be dependent upon previous own lags. The conditional variance equation in the simplest case can be expressed as follows.

$$\sigma^2_t = v\alpha_0 + \alpha_1 u^2_{t-1} + \beta\, \sigma^2_{t-1} \qquad 2.1$$

This is a GARCH(1, 1) model. σ^2_t is known as the *conditional variance* (it is referred to as h_t in most of the software packages. σ^2_t is a function of three terms:

A constant term ($v\alpha_0$, a weighted function of a long-term average value); (ii) information about volatility from the previous period, measured as the lag of the squared residual from the mean equation: ($\alpha_1 u^2_{t-1}$, the ARCH term); and, (iii) the previous period's forecast variance: ($\beta\, \sigma^2_{t-1}$, the GARCH term). The model turns out to be effectively an ARIMA model for the conditional variance.

[23] Chapoto and Jayne, 2010.

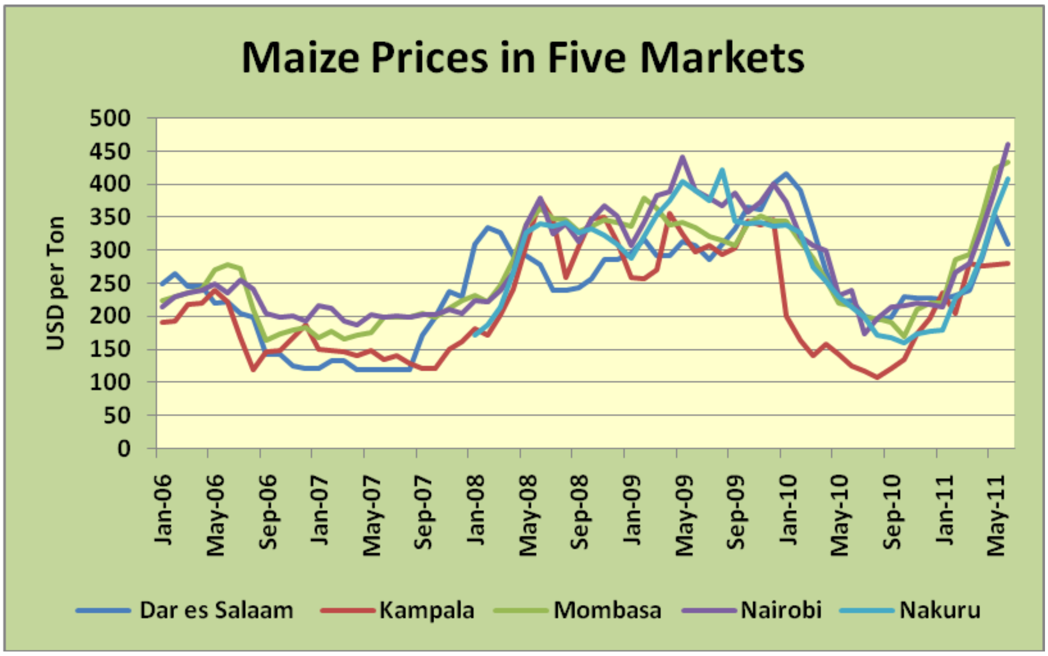
[24] Idem.

[25] See Engle, 2003.

2.2.2 Empirical measurement of volatility

For four of the markets (Nairobi, Mombasa, Dar-es-Salaam and Kampala) monthly maize prices from January 2006 to June 2011 have been used. For the fifth market, Nakuru, the available price series only covered 3 ½ years, from January 2008 to June 2011. Figure 22 shows price developments.

Figure 22
Monthly maize prices in markets in Kenya, Tanzania and Uganda



Source: Data provided by RATIN.

2.2.2.1 Measurement of unconditional volatility

Table 11 shows the Mean, Standard deviation and the coefficient of variation in all the three price series taken from three different markets in Kenya, as well as Dar-es-Salaam and Kampala. Volatility in the trend component suggests long term volatility in the price series while the volatility in the cyclical component suggests short term volatility. The table shows that in Kenya, most of the unconditional volatility in the price series comes from short term factors; while in Dar-es-Salaam and Kampala, most comes from long-term factors.

2.2.2.2 Conditional volatility in maize prices in five markets

This analysis had to rely on very short time series of 50 observations, which is generally considered too small to permit reliance on the asymptotic theory that informs the models that are used. This is quite clear for unit roots and GARCH models. Results are thus very weak, and could well be due to spurious correlations rather than to underlying time series properties of the data. The results presented in this section and the next three should be interpreted with this caveat in mind.

Table 11
Unconditional volatility in maize prices in three markets of Kenya

Market	Mean	Standard Deviation	Coefficient of Variation
Nairobi	277.55	76.91	27.71
Hptrend_Nairobi	277.55	39.36	14.18
Cycle_Nairobi		59.99	
Mombasa	266.65	72.49	27.19
Hptrend_Mombasa	266.65	34.63	12.99
Cycle_Mombasa		58.74	
Nakuru	289.88	77.65	26.79
Hptrend_Nakuru	289.88	20.53	7.08
Cycle_Nakuru		70.43	
Dar_Es_Salaam	245.92	76.73	31.20
Hptrend_Dar_Es_Salam	245.92	63.58	25.85
Cycle_Dar_Es_Salaam		29.70	
Kampala	217.42	78.66	36.18
Hptrend_Kampala	217.42	64.26	29.56
Cycle_Kampala		34.10	

To estimate the conditional variance series first we test for the unit root in the log transformed raw price series, which turns out to be I(1) therefore we work with the first difference of the log transformed series which represents the inflation rate in maize price series. There is no significant lag in the auto-correlation function of the series; therefore, we have chosen to model our conditional mean equation without any regressors in it (the detailed data can be found in annexes 4 to 8 of this paper). We have modeled the conditional variance as a GARCH (1,1) process which generally can capture most types of volatilities encountered in the time-series data. We provide the results of the GARCH estimations for the five markets in section 2.2.2.4, and the conditional variances in figures 23 to 27. The results of the unit root tests and other empirical results for the five markets are presented in Annexes 4 to 8.

The conditional coefficient of variance, as shown in the following five figures, measures the unpredictable component of price variation. It does this by modelling predicted prices (based on production, world market prices, seasonality), and comparing actual prices with these predicted prices.

Nairobi has the second highest conditional variance of all five markets, after Kampala. It had considerable persistence of unpredictable fluctuations until March 2008. Then it drops till August 2008, after which it again increases and does not abet till May 2010. After this it reaches a low in August 2010. The year 2011 has again seen some increase in levels of unpredictable price variations..

Figure 23

Conditional variance, maize, Nairobi

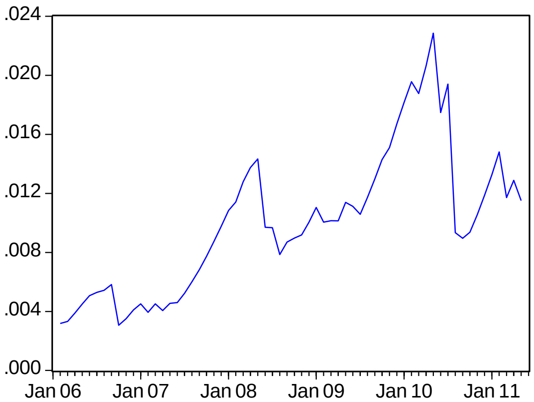


Figure 24

Conditional variance, maize, Mombasa

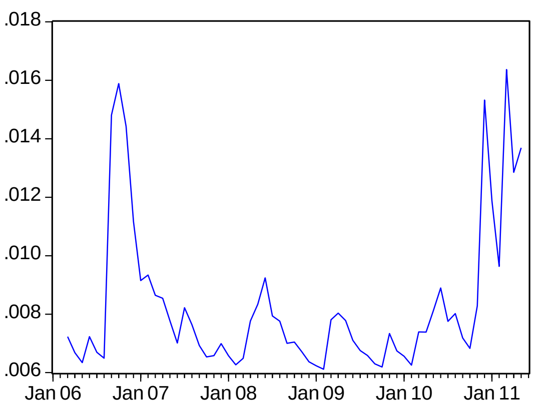


Figure 25

Conditional variance, maize, Nakuru

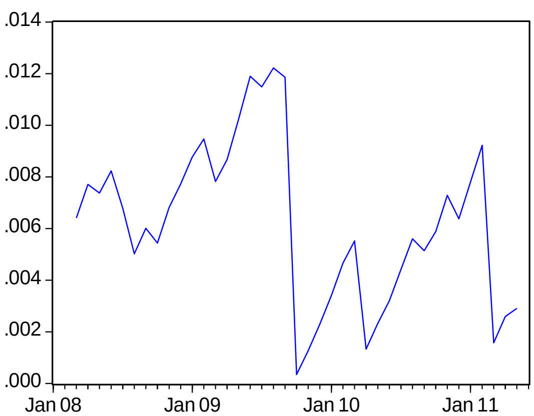


Figure 26

Conditional variance, maize, Dar-es-Salaam

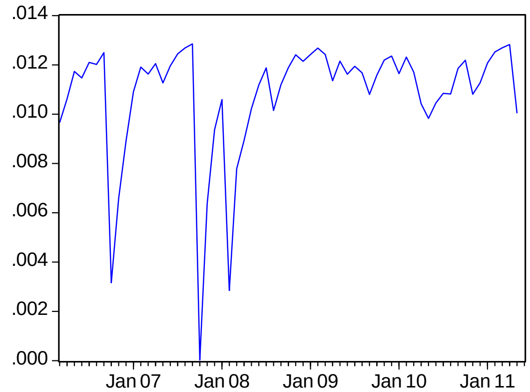
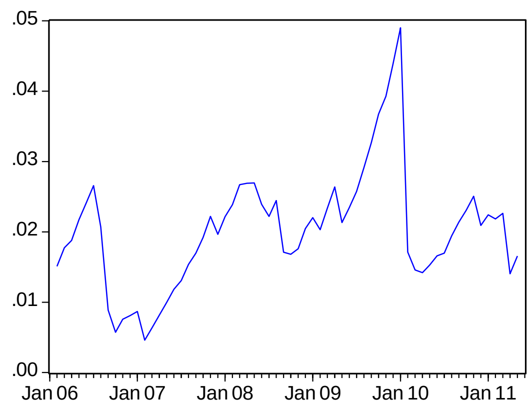


Figure 27

Conditional variance, maize, Kampala



For Mombasa, results show there is considerable drop in the conditional variance after October 2006 which lasts till December 2010. The year 2011 has again seen resurgence of unpredictability in maize prices.

It can be seen from Figure 25 that the Nakuru market also displays sharp conditional variance, albeit at levels lower than Kampala, Nairobi and Mombasa – perhaps because it is in the middle of one of the country's main maize producing districts.

The Dar es Salaam market shows an almost continuously moderately-high conditional variance – it does not reach the peak levels of Nairobi or Mombasa, but much of its time its level of price unpredictability is higher than that of the other markets.

Kampala has by far the highest conditional variance of the five markets. Most of the time, it is higher than even the peak level seen in Nairobi.

2.2.2.3 Comparing unconditional and conditional variance in maize prices

Section 2.2.2.1 discusses unconditional variance of maize prices in five East African markets – in other words, the variance shown in the behavior of prices. Section 2.2.2.2 then looks at conditional variance, which means the variance that is not explicitly explained by a past sequence of observations – in this case, past prices. When the numbers found in these two sections are compared, it is clear that virtually all of the price fluctuations that are observed in the five markets can be modeled as dependent on past prices – i.e., they are predictable.

Table 12
Comparing unconditional and conditional coefficients of variation

Market	**Unconditional CV (%)**	**Conditional CV (%)**
Nairobi	27.7	0.4 – 2.4
Mombasa	27.2	0.6 – 1.6
Nakuru	26.8	0.1 – 1.2
Dar-es-Salaam	31.2	0 – 1.3
Kampala	36.2	0.4 – 5.0

Market participants can adjust their behavior on the basis of observed events, and thus, there is no need for another agency to help them protect themselves from predictable price fluctuations. And when considering the conditional variance, the welfare benefits of eliminating such low levels of volatility in terms of both producer and consumer benefits are very low, and hence, significant public expenditure for maize price stabilization cannot be justified.

2.2.2.4 GARCH (1,1) results

As can be seen from Tables 13 to 17, GARCH estimation is divided into two sections: the upper part provides the standard output for the mean equation. The upper panel in the table, labeled as “Variance Equation”, provides the coefficients, standard errors, z-statistics and p-values for the coefficients of the variance equation. The lower panel of the output presents the standard set of regression statistics using the residuals from the mean equation. Note that measures such, R-squared is not meaningful if there are no regressors in the mean equation.

Table 13

Empirical estimates of conditional variance for maize prices, Nairobi

Dependent Variable: D_LN_NAIROBI
Method: ML - ARCH (Marquardt) - Normal distribution
Sample (adjusted): 2006M02 2011M05
Included observations: 64 after adjustments
Convergence achieved after 13 iterations
Variance backcast: ON
GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.006838	0.007494	0.912495	0.3615
Variance Equation				
C	0.000247	0.000274	0.900941	0.3676
RESID(-1)^2	-0.113696	0.084534	-1.344971	0.1786
GARCH(-1)	1.100626	0.096695	11.38247	0.0000

R-squared	-0.000643	Mean dependent var	0.009385
Adjusted R-squared	-0.050675	S.D. dependent var	0.101231
S.E. of regression	0.103764	Akaike info criterion	-1.868047
Sum squared resid	0.646021	Schwarz criterion	-1.733117
Log likelihood	63.77750	Durbin-Watson stat	1.887754

Table 14

Empirical estimates of conditional variance for maize prices, Mombasa

Dependent Variable: D_LN_MOMBASA
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 06/30/11 Time: 13:57
Sample (adjusted): 2006M03 2011M05
Included observations: 63 after adjustments
Convergence achieved after 22 iterations
Variance backcast: ON
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.011817	0.019725	0.599074	0.5491
AR(1)	0.304652	0.146055	2.085871	0.0370
		Variance Equation		
C	0.002155	0.003095	0.696177	0.4863
RESID(-1)^2	0.126792	0.178829	0.709014	0.4783
GARCH(-1)	0.625053	0.484021	1.291375	0.1966

R-squared	0.087373	Mean dependent var	0.009671
Adjusted R-squared	0.024433	S.D. dependent var	0.095678
S.E. of regression	0.094502	Akaike info criterion	-1.839093
Sum squared resid	0.517980	Schwarz criterion	-1.669003
Log likelihood	62.93142	Durbin-Watson stat	2.031348
Inverted AR Roots	.30		

Table 15

Empirical estimates of conditional variance for maize prices, Nakuru

Dependent Variable: D_LN_NAKURU
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 06/30/11 Time: 14:17
Sample (adjusted): 2008M03 2011M05
Included observations: 39 after adjustments
Convergence achieved after 35 iterations
MA backcast: 2008M02, Variance backcast: ON
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.089040	0.080426	1.107100	0.2683
AR(1)	0.918123	0.088630	10.35904	0.0000
MA(1)	-0.548096	0.148592	-3.688597	0.0002
Variance Equation				
C	0.001061	0.000481	2.205048	0.0275
RESID(-1)^2	-0.195929	0.083219	-2.354383	0.0186
GARCH(-1)	1.059332	0.030985	34.18858	0.0000

R-squared	0.280456	Mean dependent var	0.016658
Adjusted R-squared	0.171434	S.D. dependent var	0.105319
S.E. of regression	0.095868	Akaike info criterion	-2.008924
Sum squared resid	0.303289	Schwarz criterion	-1.752992
Log likelihood	45.17402	Durbin-Watson stat	1.973666
Inverted AR Roots	.92		
Inverted MA Roots	.55		

Table 16

Empirical estimates of conditional variance for maize prices, Dar-es-Salaam

Dependent Variable: D_LN_DAR_ES_SALAAM
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 06/30/11 Time: 18:04
Sample (adjusted): 3 65
Included observations: 63 after adjustments
Convergence achieved after 48 iterations
MA backcast: 1 2, Variance backcast: ON
GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.005214	0.024405	0.213646	0.8308
AR(1)	0.158635	0.513896	0.308691	0.7576
MA(1)	0.217819	0.483343	0.450652	0.6522
MA(2)	0.268545	0.195055	1.376763	0.1686
	Variance Equation			
C	0.006354	0.003985	1.594380	0.1109
RESID(-1)^2	-0.100265	0.033687	-2.976426	0.0029
GARCH(-1)	0.511924	0.358973	1.426079	0.1538

R-squared	0.134096	Mean dependent var	0.004506
Adjusted R-squared	0.041321	S.D. dependent var	0.112069
S.E. of regression	0.109729	Akaike info criterion	-1.569998
Sum squared resid	0.674267	Schwarz criterion	-1.331872
Log likelihood	56.45494	Durbin-Watson stat	2.103270

Inverted AR Roots	.16	
Inverted MA Roots	-.11+.51i	-.11-.51i

Table 17

Empirical estimates of conditional variance for maize prices, Kampala

Dependent Variable: D_LN_KAMPALA
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 06/30/11 Time: 18:25
Sample (adjusted): 2 65
Included observations: 64 after adjustments
Convergence achieved after 21 iterations
Variance backcast: ON
GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.004193	0.016814	0.249381	0.8031
Variance Equation				
C	0.001360	0.001342	1.013033	0.3110
RESID(-1)^2	-0.122597	0.042654	-2.874256	0.0040
GARCH(-1)	1.085109	0.089630	12.10653	0.0000

R-squared	-0.000121	Mean dependent var	0.005921
Adjusted R-squared	-0.050127	S.D. dependent var	0.158093
S.E. of regression	0.162007	Akaike info criterion	-0.891422
Sum squared resid	1.574767	Schwarz criterion	-0.756492
Log likelihood	32.52550	Durbin-Watson stat	1.637483

2.3 Integration of five maize markets in Kenya, Tanzania and Uganda

If there is flow of information across markets and output flows from surplus regions to deficit regions then the prices across the region will move together and there will be long run relationship between the price movements across the markets. This spatial dimension of efficiency of markets has been tested using the cointegration between the prices across the five markets analyzed in this study. Monthly data on maize prices for the five markets have been used, measured in US Dollar terms so as to ensure their comparability. The time period for which this data was available was January 2008 to June 2011.

The correlation coefficients of maize prices in these five markets of the three countries are presented in the following table – note that the length of the time series, encompassing only some 50 observations, is such that the results are not very robust.

Table 18

Correlation coefficients of maize prices in five markets: January 2008 to June 2011

MARKET	LN_Mombasa	LN_Nairobi	LN_Nakuru	LN_Dar_Es_ Salaam	LN_Kampala
LN_Mombasa	1	0.92	0.92	0.61	0.82
LN_Nairobi	0.92	1	0.95	0.65	0.79
LN_Nakuru	0.92	0.95	1	0.59	0.77
LN_Dar_Es_Salaam	0.61	0.65	0.59	1	0.44
LN_Kampala	0.82	0.79	0.77	0.44	1

The correlation coefficient is lowest for Dar es Salaam-Kampala pair of markets (0.44) and highest for the Nairobi-Mombasa pair of markets (0.92). By and large, the correlation coefficients are rather high leading to the conclusion that there is co-movement of prices in these markets.

The results of the unit root tests on the price series in these markets are reported in Annex 9 to Annex 14. All the series have unit roots in log levels and are I(1) processes and become stationary only after differencing them. The following Table indicates the cointegrating vectors of maize prices across the five markets. The existence of one or more cointegrating vectors can be seen with Trace test.

Table 19

Cointegrating vectors of maize prices across the five markets

Sample: 2008M01 2011M06
Included observations: 40
Series: LN_DAR_ES_SALAAM LN_KAMPALA LN_MOMBASA LN_NAIROBI LN_NAKURU
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	2	3	2	5
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	214.3182	214.3182	214.9724	214.9724	215.1789
1	228.2696	228.9744	229.5777	230.4343	230.5735
2	238.4828	240.0701	240.4977	244.9950	245.1329
3	243.9235	250.1014	250.2349	255.2540	255.3801
4	246.3407	255.4197	255.4772	262.7142	262.7501
5	246.3430	257.3937	257.3937	265.0024	265.0024
	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	-9.465908	-9.465908	-9.248620	-9.248620	-9.008947
1	-9.663481	-9.648721	-9.478885	-9.471717	-9.278676
2	-9.674138*	-9.653504	-9.524884	-9.649751	-9.506647
3	-9.446174	-9.605072	-9.511744	-9.612702	-9.519006
4	-9.067036	-9.320983	-9.273860	-9.435708	-9.387506
5	-8.567152	-8.869686	-8.869686	-9.000120	-9.000120
	Schwarz Criteria by Rank (rows) and Model (columns)				
0	-8.410358*	-8.410358*	-7.981961	-7.981961	-7.531178
1	-8.185711	-8.128729	-7.790005	-7.740616	-7.378687
2	-7.774148	-7.669071	-7.413784	-7.454208	-7.184438
3	-7.123965	-7.156197	-6.978425	-6.952716	-6.774577
4	-6.322607	-6.407666	-6.318320	-6.311281	-6.220857
5	-5.400503	-5.491927	-5.491927	-5.411251	-5.411251

Table 20

Long term relationship given by the cointegrating equations

Equation No.	Dependent Variable	Dummy	Trend	LN_Nai	LN_Mom	LN_Nak	LN_Kam	LN_Dar
1	LN_Nai	-0.40	0		+0.35	+0.15	+0.29	+0.29
2	LN_Mom	1.16	-0.01	+2.89		-0.44	-0.84	-0.85
3	LN_Nak	2.66	-0.02	+6.63	-2.30		-1.92	-1.94
4	LN_Kam	1.38	-0.01	+3.45	-1.20	-0.52		-1.01
5	LN_Dar	1.36	-0.01	3.41	-1.18	0.52	-0.99	

LN_Nai = LN_Nairobi(-1)
LN_Mom = LN_Mombasa(-1)
LN_Nak =LN_Nakuru(-1)
LN_Kam =LN_Kampala(-1)
LN_Dar =LN_Dar_Es_Salaam(-1)
It may be noted that prefix LN indicates the log of the monthly price of the market which is suffixed.

The following conclusions can be inferred from the above analysis:

- The relation with trend is slightly negative for all markets except Nairobi
- Prices in Nairobi are positively related with all the other markets
- Prices in Mombasa are negatively related to prices in Kampala, Dar Es Salaam and Nakuru and positively with prices in Nairobi
- Prices in Nakuru are positively related with prices in Nairobi and negatively with all other markets
- Prices in Dar Es Salaam are negatively related with prices in Kampala, Mombasa and Nakuru but positively related with prices in Nairobi.
- Prices in Kampala are negatively related with prices in Dar Es Salaam, Mombasa and Nakuru but positively related with prices in Nairobi

In brief, prices in Nairobi are positively correlated with prices in all other markets and hence all markets seem to be driven by Nairobi market, which is the main consumption market in the region. The integration of Dar Es Salaam and Kampala with other markets seems to be weaker (indicating that borders negatively influence maize flows and thus, even for this recent period, the East African common maize market was not fully effective).

These findings mostly confirm those of a study using 2000-2008 price data for a larger group of markets in East Africa.[26] This study also found a predominant role of Nairobi in price formation, reflecting both its superior infrastructure links with other towns and the importance of its local demand for maize. But whereas a strong effect was found for crossing Tanzania's border, different from the findings above, no such effect was found for the Uganda-Kenya border – the two countries' prices were well-integrated. Furthermore, this study assessed price transmission inside the three countries, and found that this was weakest in Tanzania – a reflection of its poor transport infrastructure.

2.4 Model for determining maize price in Kenya: 1980-2007

2.4.1 Behavioral model for determining maize price in Kenya

Given the availability of annual maize prices only for Kenya for adequate length of the time series, a model has been tested to quantify the determinants of maize prices for Kenya.

Nominal price of any commodity is determined by both the demand and supply conditions. The demand for a commodity is determined by the nominal price of that commodity, nominal price of the other substitute commodities and by other macroeconomic factors, such as, liquidity conditions in the economy and the real income of the people, *etc.* Presuming that maize is a normal good and is a predominant component of diet in Kenya with limited substitutability by other goods, we hypothesize that the demand for maize (QD) would depend upon: (i) nominal price of maize; (ii) real GDP; and, (iii) money supply. We state this in equation 3.1.1. As can be seen from equation 3.1.1, we expect demand for maize to be positively related to money supply (MS) and real GDP (RGDP) and inversely to the nominal price (NP). It may be noted that 't' denotes the time subscript and 'u' denotes the random error term. The parameters to be estimated in equation 3.1.1 are 'a', 'b', 'c', and 'd'.

$$QD_t = a - b*NP_t + c*MS_t + d*RGDP_t + u_t \quad \ldots\ldots \textit{Equation } \textbf{\textit{3.1.1}}$$

The domestic supply of maize (QS) in any year is defined to consist of the quantity of production of maize in that year (QP), plus the quantity of imports (IM), plus the stock of maize carried over from the previous year (ST), minus the exports of maize (EX) in the same year. This is specified in equation 2,

Model variables: abbreviations used

CPI	Consumer price index	QS	Domestic supply of maize
EX	Quantity of maize exports	RGDP	Real GDP
IM	Quantity of maize imports	RP	Real price of maize
MS	Money supply	ST	Maize stock carried over from previous year
NP	Nominal price		
QD	Domestic demand for maize	t	Time subscript
QP	Quantity of maize production	u	Random error term

which is an identity and not a behavioural equation.

$$QS_t = QP_t + IM_t + ST_t - EX_t \quad \ldots\ldots \textit{Equation } \textbf{\textit{3.1.2}}$$

[26] Ihle et al., 2011.

The supply side is treated as given. This is because modeling of production which is a predominant component of QS would require time-series data on variables, such as, rainfall, fertilizer consumption inputs, etc., data which were not available.

Equilibrium price is supposed to be reached when $QD_t = QS_t$.

The inverse demand function is defined as follows.

$$NP_t = \alpha - \beta^* QS_t + \gamma^* MS_t + \lambda^* RGDP_t + e_t \quad \ldots\ldots \textbf{\textit{Equation 3.1.3A}}$$

$$NP_t = \alpha - \beta^* QS_t + \pi^* (MS/RGDP)_t + \varepsilon_t \quad \ldots\ldots \textbf{\textit{Equation 3.1.3B}}$$

Alternatively, one can hypothesize that the real price of maize (RP) would be determined by only by the supply of maize, as indicated in equation 4. As would be recalled, RP = NP/CPI[27]. The logic here is that since CPI is already factored into the RP, which in turn is determined by the money supply and GDP, one can safely exclude the latter variables from the analysis in view of the data constraints and other statistical problems, such as, multicollinearity.

$$RP_t = \alpha - \beta^* QS_t \qquad \ldots\ldots \textbf{\textit{Equation 3.1.4}}$$

$$CPI_t = a_0 + b_0^* MS_t - c_1^* RGDP_t + \mu_t \quad \ldots\ldots \quad \textbf{\textit{Equation 3.1.5A}}$$

$$CPI_t = a_1 + b_1^* (MS/RGDP)_t + \nu_t \quad \ldots\ldots \textbf{\textit{Equation 3.1.5B}}$$

In order to get the estimates of elasticities, the log transformations of these variables are used in the empirical study.

First, the correlation coefficient matrix is indicated for the variables included in equations 3.1.3 to 3.1.5B. It can be seen from Table 21 that except the RP, all the variables are highly collinear. In view of this, the money supply (MS) variable is combined with the Real GDP variable so as to capture the effect of both the variables on prices as indicated in equations 3.1.3B and 3.1.5B.

[27] It may be noted that since the CPI is equated to 100 in the base year, the RP has to be multiplied by 100.

Table 21

Correlation coefficients among the variables

Variables in log	NP	RP	QS	MS	RGDP	CPI	MS_RGDP
NP	1						
RP	-0.0407	1					
QS	0.9403	-0.2478	1				
M3	0.9748	-0.2497	0.9656	1			
RGDP	0.9117	-0.3208	0.9073	0.9519	1		
CPI	0.9805	-0.2361	0.9632	0.9971	0.9497	1	
MS_RGDP	0.9753	-0.2224	0.9649	0.9954	0.918	0.9923	1

Table 22

Determinants of Nominal Price (NP)

Explanatory Variable	Coefficient	Std. Error	t-statistics	Level of Significance
MS_RGDP	0.7339	0.4200	1.75	0.0930
NP1	0.4338	0.2887	1.50	0.1460
QS	-1.0732	1.2601	-0.85	0.4030
_CONS	14.6305	11.6690	1.25	0.2220

Number of obs =	28
F(2, 25) =	423.65
Prob > F =	0
R-squared =	0.9601
Root MSE =	0.21577
Durbin-Watson d-statistic(3, 28) =	1.883896

Table 23

Determinants of Real Price (RP)

Explanatory Variable	Coefficient	Std. Error	t-statistics	Level of Significance
RP1	0.4046	0.3365	1.2000	0.2410
QS	-0.2627	0.1943	-1.3500	0.1890
_CONS	7.8666	4.3730	1.8000	0.0840

Number of obs =	28
F(2, 25) =	3.87
Prob > F =	0.0344
R-squared =	0.2052
Root MSE =	0.19063
Durbin-Watson d-statistic(3, 28) =	1.895164

As can be seen from the above tables, the price of maize is inversely related to the supply of maize. However, the dominant impact of overall macro factors such as liquidity per unit of GDP is also evident in the determination of nominal price. The price (nominal) elasticity of demand is about 0.93, whereas, for liquidity it is about 3.80. The near unitary elasticity of demand for maize implies that people keep their expenditure on maize more or less the same. In the event of rising prices, people will cut down on their consumption and this has adverse implication for the food security. Similarly, it also implies that one percent increase in food supply can reduce prices by the same percentage and lead to a one percentage increase in consumption of maize. Thus, imports or release of stocks of maize do have a depressing effect on the price of maize and a positive effect on consumption of maize. In brief, there is a case for intervention either through imports or through maintenance of buffer stocks, or for promotion of market-based instruments so as to stabilize prices and to alleviate food insecurity.

2.4.2 Time series model for determining nominal maize price in Kenya

In order to get more robust results for determinants of nominal and real prices of maize in Kenya, the Johansen and Juselius Cointegration Test and the Vector Error-Correction Model are applied. Also, the Dynamic Analysis in a Cointegrated VAR Framework is performed to estimate the impulse response functions.

The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests results are presented in Annex 5.11. The optimal lag lengths for the ADF test were chosen based on the Akaike Information Criterion (AIC), while for the PP test, it is based on the automatic selection procedure of Newey-West (1994) for Bartlett kernel. In the levels form, results show that the null hypothesis of the existence of a unit root cannot be rejected at the conventional significance levels. Nevertheless, both tests clearly show that all data are stationary in their first differences, indicating that they are I(1) processes. The unit root test results satisfy the condition that all data should have the same order of integration for them to be cointegrated.

2.4.2.1. Johansen and Juselius Cointegration Test

Once the order of integration of each time series is determined, the next step is to test for the cointegration relationship among the variables in the model. The Johansen maximum likelihood method from Johansen and Juselius (1990) is utilized to examine the number of cointegrating vector(s) in the model. Table 24 reports the Johansen-Juselius multivariate cointegration test results. As shown in Table 24, the null hypothesis of zero cointegration (r = 0) is rejected both by the trace (λ_{trace}) and maximum eigen value ($\lambda_{\max}$) statistics at the 5 percent significant level. Therefore, the null hypothesis of at most one cointegrating vector cannot be rejected. This implies that there is a single cointegrating vector in the model, and consequently there is a long run stable linear equilibrium relationship among the three variables in the system.

Table 24

Johansen and Juselius Cointegration Test Results

Panel A: Unrestricted Cointegration Rank Test (Trace)

Null (H_o)	Alternative (H_1)	Eigenvalue	Trace Statistics	5% Critical Value	*p*-Value
Variables: NP, QS, MS_RGDP					
***r* = 0**	***r* = 1**	**0.741768**	**53.73526**	**42.91525**	**0.0030**
$r \leq 1$	$r = 2$	0.471186	21.24169	25.87211	0.1695
$r \leq 2$	$r = 3$	0.219602	5.950835	12.51798	0.4666

Notes: (1) Test included an intercept and trend in the cointegrating vector.
(2) *r* is the number of cointegrating vectors.

Panel B: Unrestricted Cointegration Rank (Maximum eigenvalue)

Null (H_o)	Alternative (H_1)	Eigenvalue	Maximum eigenvalue Statistics	5% Critical Value	*p*-Value
Variables: NP, QS, MS_RGDP					
***r* = 0**	***r* = 1**	**0.741768**	**32.49357**	**25.82321**	**0.0057**
$r \leq 1$	$r = 2$	0.471186	15.29086	19.38704	0.1783
$r \leq 2$	$r = 3$	0.219602	5.950835	12.51798	0.4666

Notes: (1) Test included an intercept and trend in the cointegrating vector.
(2) *r* is the number of cointegrating vectors.

2.4.2.2 Estimation of Error-Correction Model

The next step is to examine the interaction among the variables in the system using the error-correction model. The VECM involves selection of appropriate lag length. An inappropriate lag selection may give rise to problems of over-parameterization or under-parameterization. Akaike information criterion (AIC), Schwarz information criterion (SIC), and Hannan-Quinn criterion (HQ) are used to select optimal lag lengths. The error-correction is estimated after choosing the appropriate lag and is summarized in Table 25.

Table 25

Estimation of Vector Error Correction Model {Standard errors in ( ) & t- statistics in [ ]}

Error Correction:	D(NP)	D(QS)	D(MS_RGDP)
ECT	-0.665030	-0.039009	-0.056963
	(0.21727)	(0.05729)	(0.11659)
	[-3.06078]	[-0.68091]	[-0.48856]
D(NP(-1))	-0.292580	0.098855	0.034472
	(0.21496)	(0.05668)	(0.11535)
	[-1.36106]	[1.74409]	[0.29884]
D(NP(-2))	-0.395588	0.052095	-0.044125
	(0.20560)	(0.05421)	(0.11033)
	[-1.92405]	[0.96097]	[-0.39994]
D(NP(-3))	-0.230840	0.037353	0.069279
	(0.19313)	(0.05092)	(0.10364)
	[-1.19527]	[0.73353]	[0.66848]
D(QS(-1))	4.238483	-0.488459	0.974503
	(1.36756)	(0.36059)	(0.73385)
	[3.09931]	[-1.35463]	[1.32793]
D(QS(-2))	3.852391	-0.425537	0.075957
	(1.42449)	(0.37560)	(0.76440)
	[2.70441]	[-1.13296]	[0.09937]
D(QS(-3))	1.346989	-0.024556	-0.159522
	(1.07976)	(0.28470)	(0.57942)
	[1.24749]	[-0.08625]	[-0.27532]
D(MS_RGDP(-1))	-0.313543	0.137631	0.187714
	(0.67020)	(0.17671)	(0.35964)
	[-0.46784]	[0.77884]	[0.52195]
D(MS_RGDP(-2))	0.483873	-0.100296	0.185815
	(0.62582)	(0.16501)	(0.33582)
	[0.77318]	[-0.60781]	[0.55331]
D(MS_RGDP(-3))	0.401103	0.077324	-0.012466
	(0.59367)	(0.15653)	(0.31857)
	[0.67564]	[0.49398]	[-0.03913]
C	-0.028382	0.001311	0.047399
	(0.06889)	(0.01816)	(0.03697)
	[-0.41198]	[0.07218]	[1.28217]

R-squared	0.727342	0.589910	0.409219
Adj. R-squared	0.517606	0.274456	-0.045228
Sum sq. resids	0.471544	0.032783	0.135783
S.E. equation	0.190454	0.050217	0.102200
F-statistic	3.467885	1.870035	0.900477
Log likelihood	13.10302	45.09624	28.04248
Akaike AIC	-0.175252	-2.841354	-1.420207
Schwarz SC	0.364689	-2.301412	-0.880265
Mean dependent	0.096649	0.017549	0.106561
S.D. dependent	0.274213	0.058955	0.099964

Determinant resid covariance (dof adj.)	6.88E-07
Determinant resid covariance	1.09E-07
Log likelihood	90.17593
Akaike information criterion	-4.514661
Schwarz criterion	-2.747580

The above Table shows that the estimated coefficient of the error correction term (ECT) has the correct negative sign and is significant, confirming further that the variables in the system are cointegrated. Also, it indicates that while nominal price may temporarily deviate from its long run equilibrium, the deviations are adjusting towards the equilibrium level in the long run. The estimated coefficient of ECT is -0.6650, implying that about 66.5 percent of the short-run deviations of the nominal prices would be adjusted each year towards the long run equilibrium level. This means that the nominal price has very quick adjustment to correct disequilibrium among the three variables in the system. On the other words it can be explained that the nominal price will converge towards its long-run equilibrium level at a very high speed, when there is a short-run deviation.

2.4.2.3. Dynamic Analysis in a Cointegrated VAR Framework

Above, the long-run relationship and short-run adjustment dynamics of the equity prices with macroeconomic and monetary policy variables has been analyzed. In the next step of the empirical analysis, the study has made use of the VAR model and reported the impulse response functions and variance decomposition results in order to analyze the dynamic interaction among nominal price, quantity supplied and money supply.

2.4.2.4. Impulse Responses

In the impulse response function analysis, the study has attempted to know the responsiveness of the dependent variables in the VAR to shocks (under standard Cholesky decomposition) to each of the variables in a VAR framework. This also explains various channels through which nominal price may be influenced. The impulse reposes of nominal price to various shocks are given in Figure 28. The impulse response function shows that the supply shock (i.e., an increase in quantity supplied) leads to decline in nominal prices with a lag, however, the money supply shock causes sudden changes in nominal prices and it persists for a quite longer period.

2.4.2.5. Variance Decompositions Analysis

After investigating the impulse response results, in the next stage of empirical exercise the study has attempted to analyze the variance decomposition results in a Cointegrated VAR frame work to find out the proportion of the movements in the dependent variables that are due to their 'own' shocks, versus shocks to the other variables. The results of decomposition of fluctuations in the nominal prices caused by macroeconomic and monetary policy shocks are presented in Table 26. The variance decompositions analysis results reveal that although the nominal price shock explains the predominant part of variations in nominal prices in the short run, it is the money supply shock that explains the largest proportion of variations in nominal prices over the medium to long run. The supply shocks tend to have some impact on nominal price only in long run.

Figure 28

Impulse response of NP, QS and MS_RGDP to various shocks

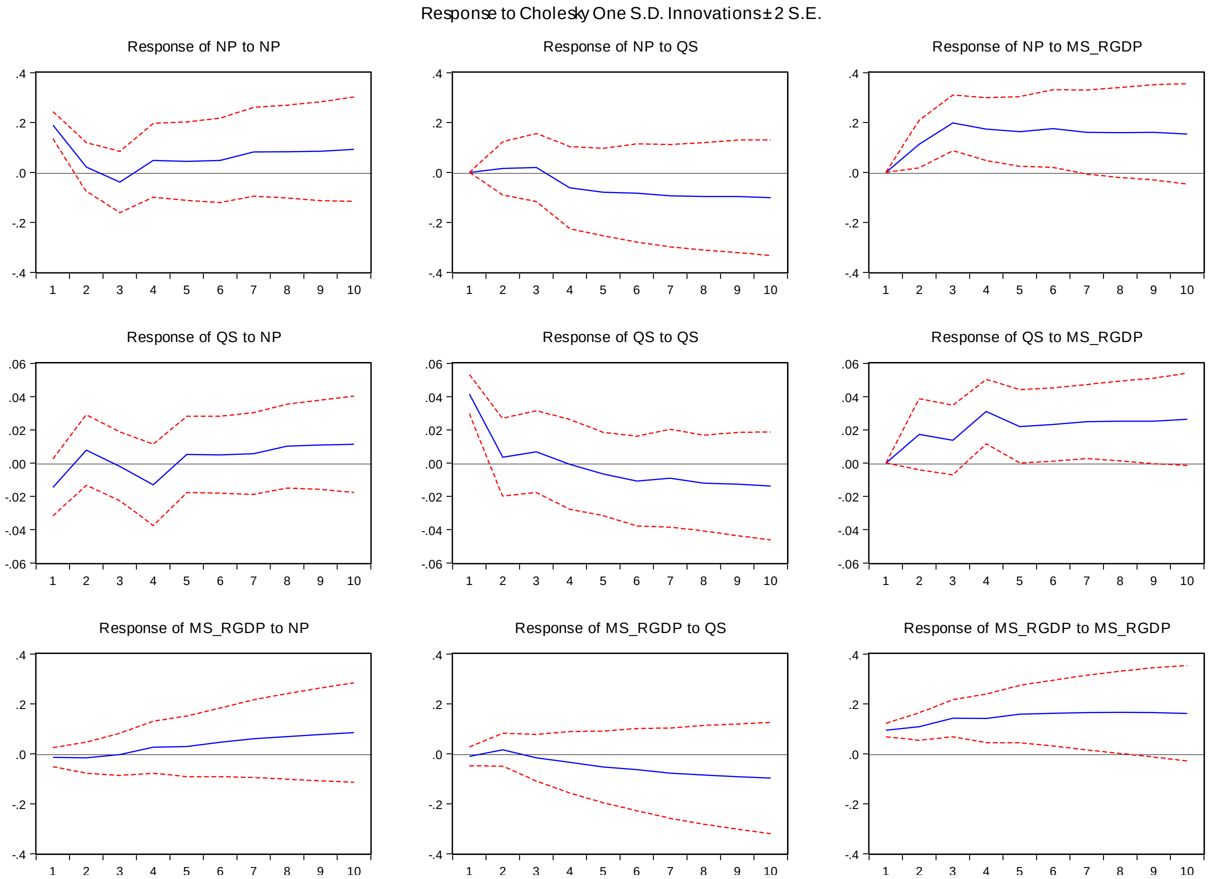


Table 26

Variance decomposition of fluctuations caused in nominal prices

Year/s	Price Shock	Supply Shock	Money Supply_GDP Shock
1	100.00	0.50	25.91
2	73.59	0.69	57.45
3	41.86	3.42	64.77
4	31.81	6.53	67.31
5	26.16	8.63	69.22
6	22.15	10.78	68.06
7	21.17	12.44	67.07
8	20.49	13.66	66.30
9	20.04	14.86	65.07
10	20.07	15.96	63.84
11	20.19	16.95	62.64
12	20.41	0.50	25.91

2.4.3 Time series model for determining real maize price in Kenya

The time-series properties of variables required for variables included in this section are reported in Annex 5.11. In Table 27, the Johansen and Juselius Cointegration Test Results for the determination of real price of maize in Kenya are reported. The period of analysis is the same as in the preceding sub-section.

Table 27

Johansen and Juselius Cointegration Test Results

Panel A: Unrestricted Cointegration Rank Test (Trace)

Null (H_o)	Alternative (H_1)	Eigenvalue	Trace Statistics	5% Critical Value	*p*-Value
Variables: RP, QS, MS_RGDP					
***r* = 0**	***r* = 1**	**0.617067**	**31.93077**	**29.79707**	**0.0280**
$r \leq 1$	$r = 2$	0.286409	8.893272	15.49471	0.3753
$r \leq 2$	$r = 3$	0.032565	0.794578	3.841466	0.3727

Notes: (1) Test included an intercept in the cointegrating vector.
(2) *r* is the number of cointegrating vectors.

Panel B: Unrestricted Cointegration Rank (Maximum eigenvalue)

Null (H_o)	Alternative (H_1)	Eigenvalue	Maximum eigenvalue Statistics	5% Critical Value	*p*-Value
Variables: RP, QS, MS_RGDP					
***r* = 0**	***r* = 1**	**0.617067**	**23.03750**	**21.13162**	**0.0267**
$r \leq 1$	$r = 2$	0.286409	8.098695	14.26460	0.3688
$r \leq 2$	$r = 3$	0.032565	0.794578	3.841466	0.3727

Notes: (1) Test included an intercept and trend in the cointegrating vector.
(2) *r* is the number of cointegrating vectors.

Table 28

Estimation of Vector Error Correction Model {Standard errors in ( ) & t- statistics in [ ]}

Error Correction:	**D(RP)**	**D(QS)**	**D(MS_RGDP)**	**Error Correction:**	**D(RP)**	**D(QS)**	**D(MS_RGDP)**
CointEq1	-0.195558	-0.060554	-0.145490	D(QS(-3))	1.344696	0.047730	0.428076
	(0.19111)	(0.04658)	(0.08617)		(1.22358)	(0.29820)	(0.55169)
	[-1.02326]	[-1.30007]	[-1.68841]		[1.09898]	[0.16006]	[0.77593]
D(RP(-1))	-0.632301	0.125461	-0.061764	D(MS_RGDP(-1))	-0.503592	0.108566	-0.190737
	(0.28033)	(0.06832)	(0.12640)		(0.76216)	(0.18575)	(0.34365)
	[-2.25558]	[1.83637]	[-0.48865]		[-0.66075]	[0.58448]	[-0.55504]
D(RP(-2))	-0.519242	0.084029	-0.138291	D(MS_RGDP(-2))	0.350308	-0.099443	0.119119
	(0.28934)	(0.07052)	(0.13046)		(0.64218)	(0.15651)	(0.28955)
	[-1.79456]	[1.19162]	[-1.06002]		[0.54550]	[-0.63538]	[0.41140]
D(RP(-3))	-0.354892	0.037871	0.018363	D(MS_RGDP(-3))	0.345537	0.065675	0.183318
	(0.25877)	(0.06306)	(0.11667)		(0.62224)	(0.15165)	(0.28056)
	[-1.37148]	[0.60050]	[0.15739]		[0.55531]	[0.43308]	[0.65340]
D(QS(-1))	2.412519	-0.252037	1.603138	C	-0.179821	0.019049	0.044143
	(1.56292)	(0.38091)	(0.70470)		(0.08099)	(0.01974)	(0.03652)
	[1.54359]	[-0.66168]	[2.27493]		[-2.22041]	[0.96510]	[1.20889]
D(QS(-2))	3.337013	-0.218451	0.738081				
	(1.60661)	(0.39155)	(0.72440)				
	[2.07705]	[-0.55791]	[1.01889]				

R-squared	0.567527	0.618880	0.546285
Adj. R-squared	0.234855	0.325710	0.197273
Sum sq. resids	0.512946	0.030467	0.104280
S.E. equation	0.198639	0.048411	0.089563
F-statistic	1.705966	2.110996	1.565232
Log likelihood	12.09314	45.97538	31.21019
Akaike AIC	-0.091095	-2.914615	-1.684182
Schwarz SC	0.448846	-2.374674	-1.144241
Mean dependent	-0.020926	0.017549	0.106561

Determinant resid covariance (dof adj.)	3.37E-07
Determinant resid covariance	5.36E-08
Log likelihood	98.73655
Akaike information criterion	-5.228046
Schwarz criterion	-3.460965

The above table shows that the estimated coefficient of the error correction term (ECT) has the correct negative sign but is statistically insignificant, confirming further that the variables in the system are cointegrated. Also, it indicates that the real price does not return to a long-run equilibrium level when there is a short-run deviation.

Figure 29

Impulse response of RP, QS and MS_RGDP to various shocks

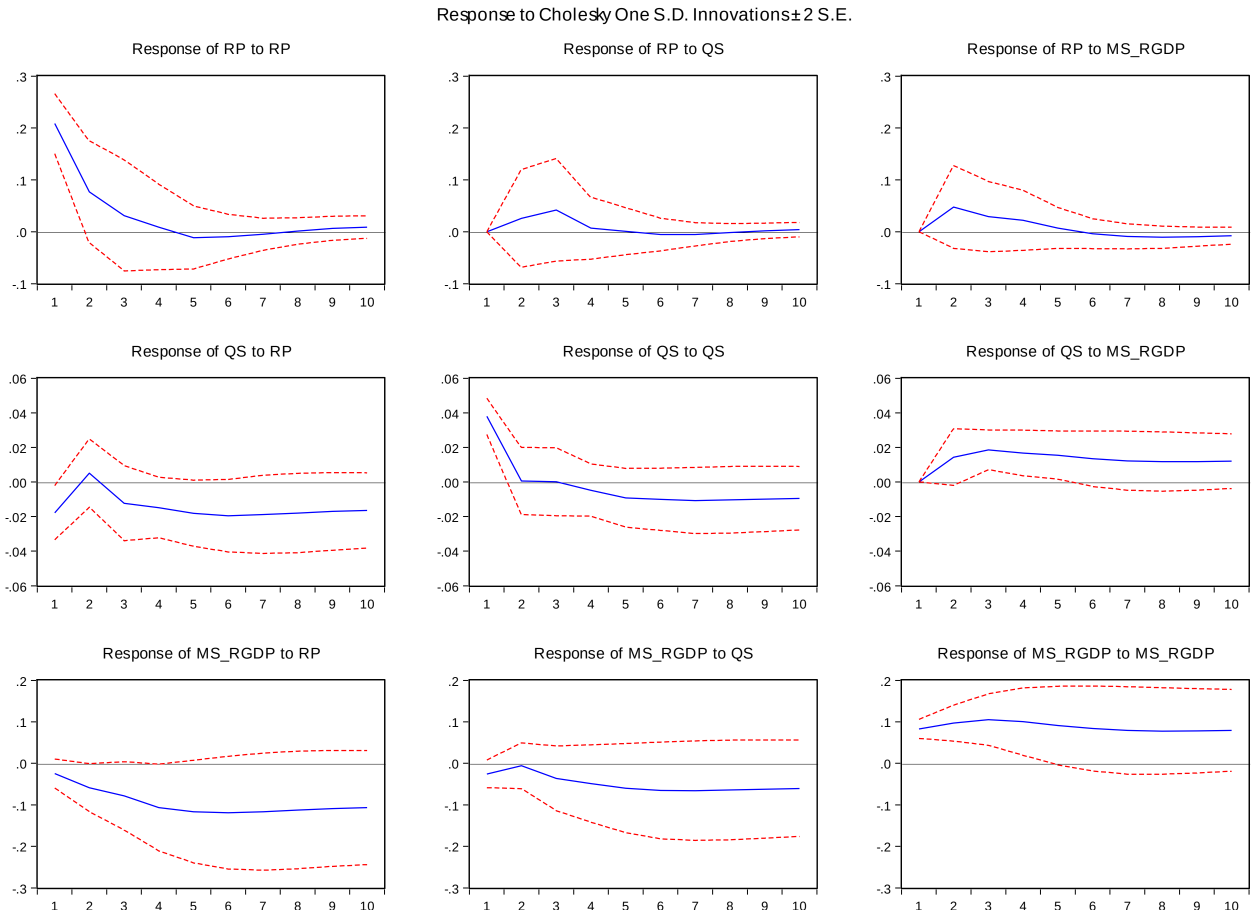


Table 29

Variance decomposition of fluctuations caused in nominal prices

Year/s	Price Shock	Supply Shock	Money Supply-GDP Shock
1	100.0000	0.000000	0.000000
2	94.38440	1.258364	4.357236
3	90.06569	4.350723	5.583583
4	89.23582	4.385837	6.378339
5	89.18005	4.373060	6.446888
6	89.12556	4.416702	6.457737
7	88.96168	4.451862	6.586456
8	88.78225	4.447229	6.770521
9	88.64538	4.440932	6.913689
10	88.54470	4.456580	6.998717
11	100.0000	0.000000	0.000000
12	94.38440	1.258364	4.357236

As can be seen from the above Table, the supply shocks and money-supply-GDP shocks do not explain the real price variation.

The conclusions emanating from the time-series approach confirm that the variables, nominal price and real price, supply of maize and money-supply per unit of GDP, are cointegrated. Also, the analysis indicates that while nominal price may temporarily deviate from its long run equilibrium, the deviations adjust towards the equilibrium level in the long run at a fairly rapid rate. The estimated coefficient of Error Correction Term is -0.6650, implying that about 66.5 percent of the short-run deviations of the nominal prices would be adjusted each year towards the long run equilibrium level. This means that the nominal price has very quick adjustment to correct disequilibrium among the three variables in the system. The variance decompositions analysis results reveal that although the nominal price shock explains the predominant part of variations in nominal prices in the short run, it is the money supply per unit of GDP shock that explains the largest proportion of variations in nominal prices over the medium to long run. The supply shocks tend to have some impact on nominal price only in long run.

2.5 Concluding remarks: data weaknesses

The analysis in this chapter was constrained by lack of data, affecting both the robustness of the results, and the overall scope of the work. A number of data gaps are worth mentioning.

Price data

- The prices used in this chapter were provided by the Regional Agricultural Trade Information Network (www.ratin.net). Long series of price data were available only for a handful of towns, and then, only on a monthly basis. The resultant number of observations was on the low side for GARCH analysis.
- Other agencies also publicise maize prices, but it is difficult to compare the various series: some are in local currency, other in US dollar terms; it is not clear whether quality standards are the same; and at what level (wholesale, retail, off-lorry) prices are measured.

Trade data

- Informal maize trade data is significant when compared to official import/export figures. This leads to a distortion of the numbers on the supply of maize in particular in Kenya.
- Data on transport, distribution and other marketing costs were not available. It would be useful to have regular /periodic data on transportation /freight and logistics costs between important production and consumption centres in the region and also, international freight rates from potential exporting countries into East Africa.
- There is a lack of monthly import/export data.
- Time series data on import/export duties are hard to find.
- Month-wise carry over stock data (especially with the national agencies like NCPB and NFRA) are not available.

Data on policy interventions

- It is not clear when exactly an intervention has occurred – when was it announced, and when was it made effective? Is it following publication in the government gazette? When it is registered in the tax and customs register? When the marketing board announces a new mandate? When parliamentary decides on a measure? When an announcement is made by the Prime Minister's Office ? When a Minister makes an announcement? Or when a measure is actually implemented at the border?
- What exactly is the intervention supposed to consist of? What is the level of tax imposed? What will be the level of marketing board intervention – will it purchase and/or sell, and in what volumes and at what purchase/sale price? Do traders or transporters need any new licenses?
- How "real" is an intervention when announced in any of the above ways? Decisions to intervene are not always clearly made, registered, communicated and gazetted... there is no single reference point to which stakeholders can refer in order to determine whether a government intervention is in place or not. Furthermore, border officials do not always follow instructions even if they have received any. They may apply discretion in their mode of intervention; and can be creative in the way that they apply border controls (e.g., creating extended delays at the border, requirements for additional papers/licenses, etc). And interventions may be difficult to apply in practice; e.g., the ban on imports of genetically modified maize should normally affect acceptable origins and thus, prices, but some cast doubt on whether the ban can actually be implemented.

- When was the intervention withdrawn? Again, there is no standard protocol or central reference point. At one occasion, the writers found that six senior civil servants in the Ministry of Agriculture of one of the countries in the study could not agree on whether an export ban was still in force... If even top government officials do not know, how likely are others to be properly informed?

Suggestions for improving data availability

- EAGC could start a data harmonisation exercise for the countries that it covers, not only in terms of prices but also other aspects of production, distribution, trade and related aspects.
- Data on transport costs between main market centres should be collected on a monthly basis. Periodical assessments should be made of other distribution and marketing costs to ascertain to what extent these fluctuate.
- Annual expert assessments should be made of the volumes involved in informal food trade in the region.
- Statistical practices in the region could be improved through better coordination (the European Commission organizes regular conferences on quality in official statistics, which may be a good example for East Africa)
- A food policy observatory could be established to monitor and register policy interventions in the region, with a commitment of governments that they will notify all interventions (and the lifting thereof) to the observatory.

Chapter 3
Risks in grain trade

From farm to fork, the maize value chain is exposed to a multitude of risks which are often interrelated. Much of this risk is expressed in price instability. This chapter briefly discusses these risks, with references, where applicable, to the specific situation in East Africa.

3.1. Institutional risks

The flow of maize from producers to consumers can be affected by many institutional factors. Some of these are related to the weakness of the value chain actors themselves; others to deficiencies in the supporting infrastructure for maize trade; yet others to unstable and unpredictable government policies and interventions. These factors, in turn, both increase the risks to which value chain participants are exposed, and reduce their ability to absorb and manage such risks.

If value chain actors are weak, their ability to act as risk buffer is weak. For example, farmers and traders may be unable to carry the burden of seasonal maize storage, leading to a relative over-supply directly after harvest and shortages later on. Because of financial constraints and the absence of specialized pre- and post-harvest finance, they may be unable to handle maize in the optimal manner – e.g., to properly treat the maize crop while it is still in the fields (exposing it to pests etc.); to dry it properly prior to storage; to store it under proper conditions; or to transport it in such a way that physical losses are minimized. Their weakness may also prevent them from accessing support services (e.g., to obtain affordable finance), and even, act as a disincentive for others to start providing services to them.

Both as a result of and contributing to the weakness of supply chain actors, the supporting infrastructure may be poor. As is indeed the case in East Africa, there may be a lack of modern, properly managed warehouses - because of past donor efforts, much of the necessary physical infrastructure exists in Kenya and Tanzania (but not in Uganda); however, the capability to manage it is weak. Not all storage facilities are equipped with good drying equipment, while farmers are often in too much of a hurry to sell their crop to dry it properly. The dusting chemicals needed to treat maize for storage can be in short supply. Trucks are often old, and they travel on poor roads. Poor price information systems lead to wasteful movements of grain and frequent charging/discharging from the trucks (especially with informal flows where maize is often unloaded onto bicycles to cross the border before being reloaded onto trucks on the other side). Formal credit systems for maize production are mostly absent in Kenya, Tanzania and Uganda, and post-harvest finance is still underdeveloped (although some progress has been made in warehouse receipt finance).

Unstable and unpredictable government policies and interventions hinder the development of strong private sector institutions and services. Private sector investors are willing to take economic risks, but are generally averse to taking political risk. Why invest in a warehouse if seasonal storage is always a risky proposition because of unpredictable government market interventions? Why would a bank develop a warehouse receipt finance scheme for farmers or traders if there is always the risk that because of a politically-driven decision to cut import tariffs, prices and hence the value of its collateral will fall dramatically?

3.2.1 Market risks - price instability

Maize prices in East Africa are unstable, but the same can be said of global maize prices. Figures 30 to 32 show average monthly maize prices in Nairobi, respectively FOB US export ports and South African prices, all expressed in US$ per ton. Apart from the evident weak correlation between the three series, it can be noted that Nairobi prices, at least for this recent period, do not show more volatility than US FOB prices or South African prices. Maize price volatility in the region is primarily driven by domestic factors rather than imported from world markets.[28]

But while price volatility in East Africa may not be larger than in international maize markets, it is still problematic for producers, consumers and governments. Consumers include farmers: in particular small ones are often net maize buyers. For example, more than half of smallholders in Kenya only buy maize and do not sell any; almost 20 per cent both buys and sells.[29]

When comparing price risk to yield risk, it is found that in Kenya, during the period from 1990 onwards, price is by far the main reason for year-to-year fluctuations in the aggregate farmers' revenue from maize (see Annex 2). In one period, yield risk was partly offset by price risk; in another, the two were positively correlated, i.e., farmers' lower yields were not compensated by higher prices.

One way to improve price stability is to enhance finance for maize storage. Another way to reduce price volatility is to improve spatial integration, through removal of trade barriers, improvement of market information, and improvement of transport infrastructure. Trade barriers are of the non-tariff kind, and exist even if there is no export ban in place – a 2007 survey, for example, found that in Kenya and Uganda, a typical maize trader could expect 6 or 7 roadblocks per 100 km (in Tanzania, the number was only two), each costing time and money.[30] As figure 33 shows, transport costs are the major transaction costs from farm to wholesale markets, and a reduction of these costs can thus have an immediate impact on consumer prices.

[28] World Bank, 2009.

[29] Jayne, Chapoto et al., 2009.

[30] Asareca, 2008

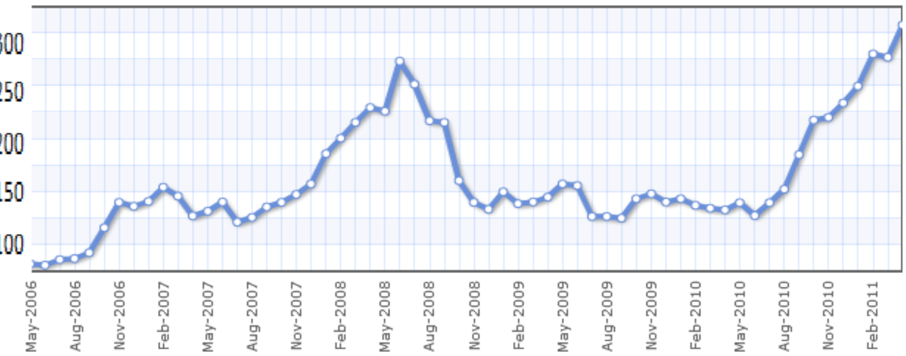
Figure 30

Monthly maize prices in Nairobi, US$/ton, May 2006-April 2011

Source: based on RATIN price data.

Figure 31

Monthly maize prices, U.S. No.2 Yellow, FOB Gulf of Mexico, US$/ton, May 2006-April 2011



Source: http://www.indexmundi.com/commodities, based on IMF price data.

Figure 32

Monthly maize prices, South Africa/Nairobi/Mbale, US$/ton, 2000-2006

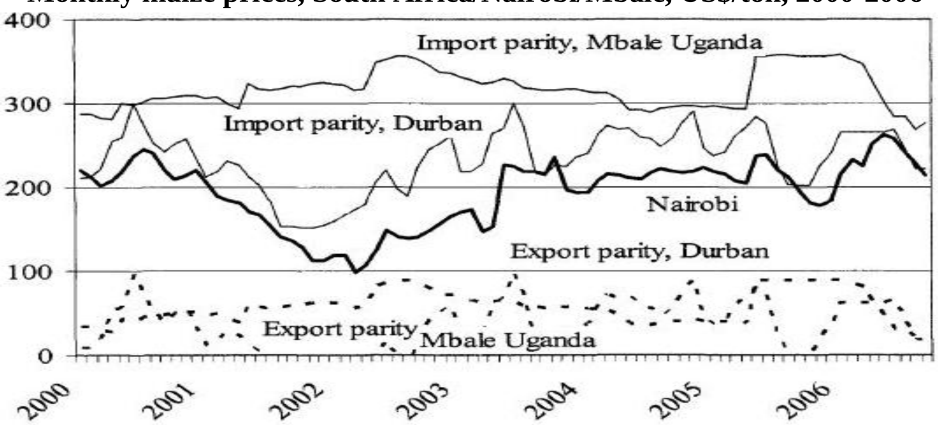
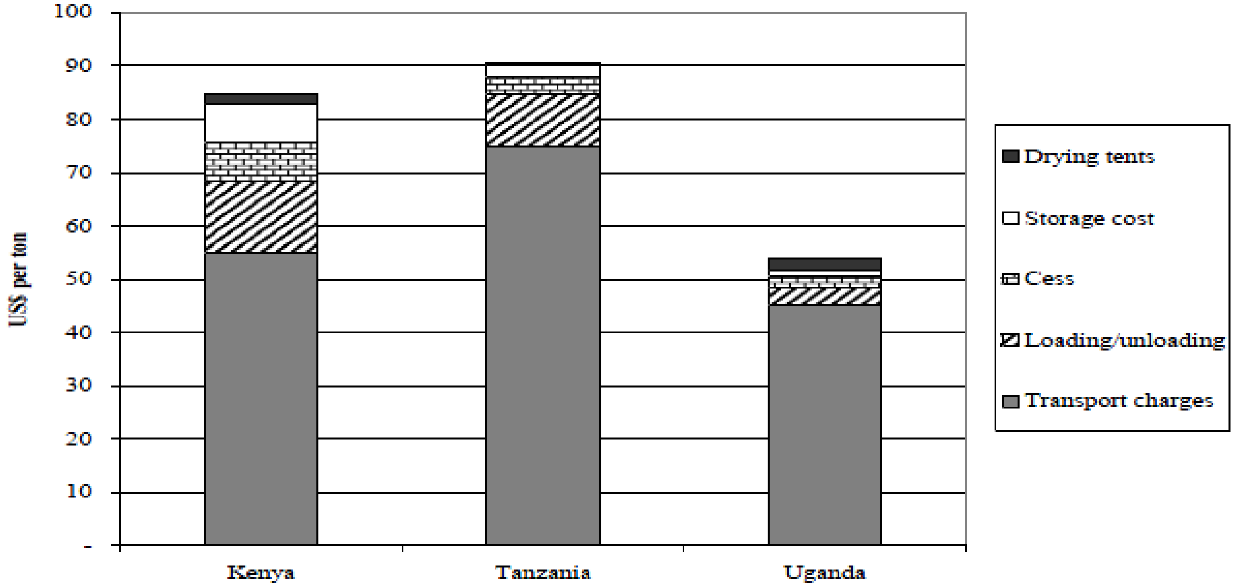


Figure 33

Structure of total marketing costs between farm-gate and urban wholesale markets by country (US$ per ton)



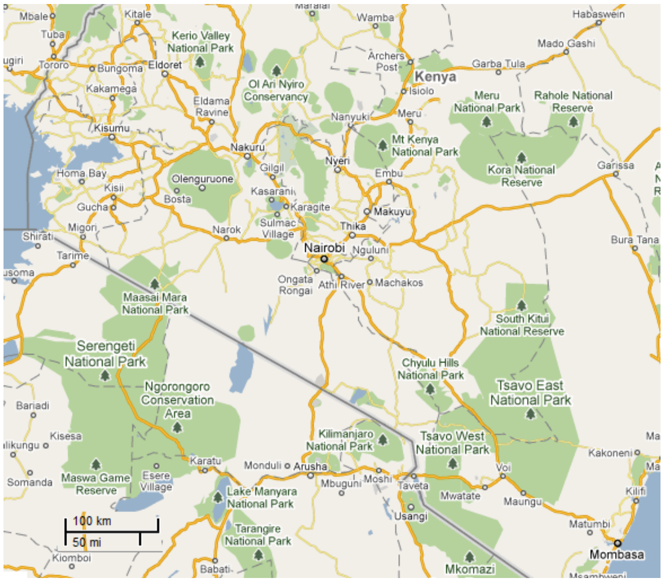
Source: World Bank, 2009. These costs do not include traders' profit margins. To put the numbers in perspective, wholesale maize prices in Nairobi, Dar-es-Salaam and Kampala were around US$ 300 during this period.

If maize moves more fluidly from surplus to deficit regions, and between neighboring countries, prices will be more stable. While as found in the previous chapter, prices between different markets show a reasonably high degree of price correlation, a closer look at prices indicates that spatial price differences are not always arbitraged away. Box 1 provides some data for Kenya. The markets mentioned are all along good all-weather roads, so one would expect price differences to move within a narrow band. However, price differentials between markets are highly volatile. E.g., during the 3 years covered in the figures, maize in Nairobi has generally been 20-40 US$ (or 10-20% in relative terms) more expensive than in Nakuru, some 130 km away; but it has been as much as 30% more expensive, and on occasions, maize has been cheaper in Nairobi than in Nakuru. Price differences between Nakuru on the one hand and Kisumu (linking with the Ugandan market) and Eldoret (maize surplus region) have fluctuated even more violently.

Interestingly, while these data indicate there is room for improvement in spatial price integration in Kenyan maize markets, a study which compares the speed of adjustment of prices between Tanzanian markets and those between Kenyan markets finds that adjustment speed in Kenya is much better than that in Tanzania.[31]

[31] Ihle, Von Cramon-Traubadel and Zorya, 2011

Box 1: Kenya - maize market integration



Kenya's maize surplus areas are in the south-western part of the country, between Nairobi (in the center of the map) and Lake Victoria (on the upper left part of the map). Maize imports from international markets enter through Mombasa (in the left bottom corner), and much of the maize imports from Uganda are through the port of Kisumu on Lake Victoria. Some 91 km northeast of Kisumu is Eldoret, in an important surplus region. Good all-weather roads lead from Kisumu and Eldoret to Nakuru (respectively 137 km and 124 km), and thence it is 130 km to Nairobi.

Figure 34: **Price difference Nairobi-Mombasa, US$/ton, April 2008-May 2011**

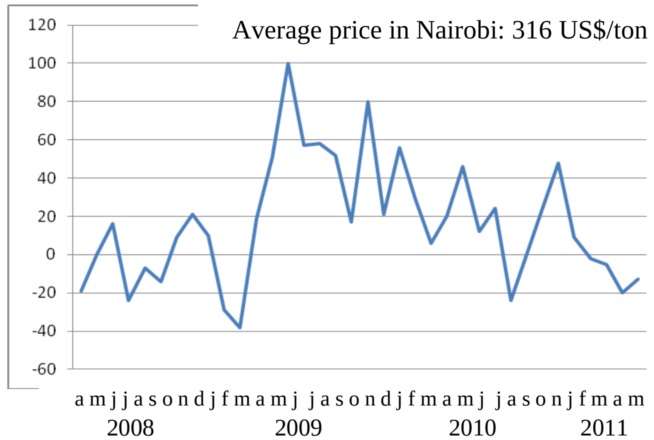


Figure 35: **Price difference Nakuru - Nairobi, US$/ton, April 2008-May 2011**

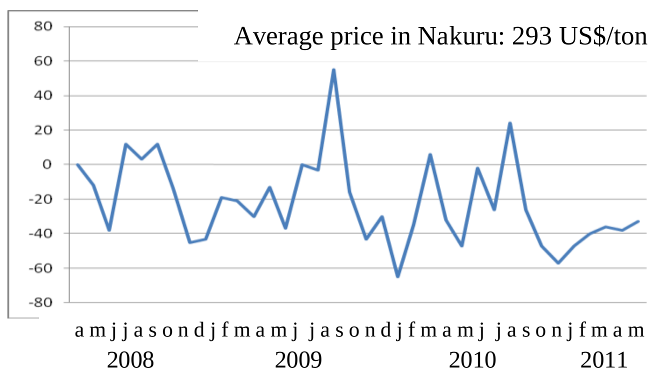


Figure 36: **Price difference Kisumu - Nakuru, US$/ton, April 2008-May 2011**

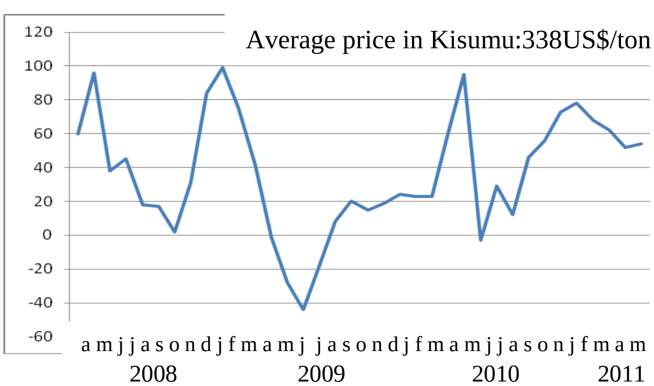
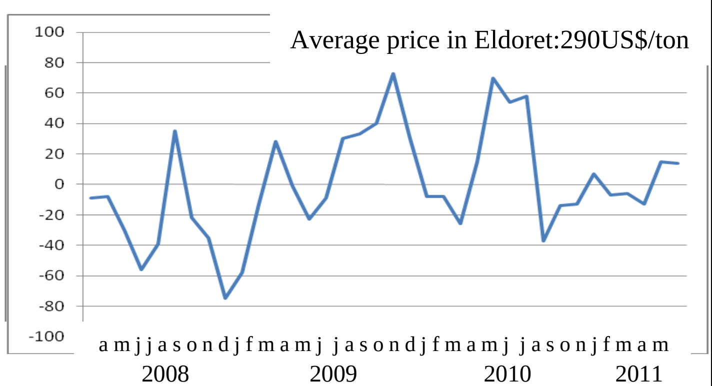


Figure 37**: Price difference Eldoret - Nakuru, US$/ton, April 2008-May 2011**



Source: calculated by authors on the basis of RATIN price data.

Some of the price movement is seasonal. In Uganda, for example, during the months of May and June, the maize price falls sharply. Prices reach their lowest level in July and August, during the main harvest period of the first season. The maize price dips again in December (in Kampala) and January (in the other two markets), corresponding to the harvest period in the second season.[32]

Because so much Ugandan maize is exported, prices are strongly influenced by prices in the surrounding countries, in particular Kenya and South Sudan. Farmgate prices in much of Eastern Uganda, for example, show much closer correlation to prices in the Kisumu market in Kenya than to Kampala prices.[33]

In terms of importing maize price risk from the international market: in Kenya, maize prices reflect world market price developments, but they do so with a rather long delay: it takes 6-9 months for Kenyan maize prices to adjust to global prices. Ugandan maize prices, other than in the export-oriented town of Mbale, do not co-move with world market prices, but they do adjust to Kenyan price developments, over a 6-7 month timeframe.[34]

3.2.2 Production /yield risk

Maize production in East Africa is rainfed, and rainfall is unstable and hardly predictable more than a few days ahead, complicating decisions on when best to sow. Farmers are exposed both to droughts and to floods - *El Nino* rains contribute much to the latter. In addition, maize yields are exposed to temperature risks: overly high temperatures during the critical growing season lead to much reduced yields (East African maize producers are therefore exposed to global warming).

3.2.3.1 Financial risks - Exchange rate fluctuations

Kenya, Tanzania and Uganda all operate free exchange rate regimes. Figures 39 to 40 show the rates of the Kenyan Shilling to the US$, as well as internal exchange rates in the region. There are significant longer-term changes, as well as fairly high short-term fluctuations, with month-to-month fluctuations of several percentage points.

[32] Haggblade and Dewina, 2010.
[33] Yamano and Arai, 2010.
[34] FAO, 2009.

Figure 38

Kenyan Shilling – US$ exchange rates, 1 June 2009 – 31 May 2011

Source: http://www.oanda.com/currency/historical-rates

Figure 39

Ugandan Shilling – Kenyan Shilling exchange rates, 1 June 2009 – 31 May 2011

Source: http://www.oanda.com/currency/historical-rates

Figure 40

Ugandan Shilling – Tanzanian Shilling exchange rates, 1 June 2009 – 31 May 2011

Source: http://www.oanda.com/currency/historical-rates

3.2.3.2 Access to credit

Better access to credit permits farmers to invest more in growing their crops; reduces farmers' incentives to diversify into less-profitable ventures just for the sake of spreading risks; and enables all value chain actors to store more, thus stabilizing intra-year prices.

Maize markets throughout East Africa were mostly liberalized during the 1990s. In the process, credit for agricultural marketing experienced a total collapse. Cooperatives (which were the traditional clients for banks' agricultural credits) fell in dire straits due to a loss of government support. At the same time, with government marketing bodies no longer acting as the principal buyers of maize, banks found it difficult to structure loans on the basis of guarantees by offtakers.

Pre-harvest finance for maize farmers is still scarce and when available, expensive.[35] In recent years, this has been a focus of development agencies, though, and a number of innovative new approaches building around mobile technology, input supply and value chains are being piloted.[36] With regards to post-harvest credit provision to farmers as well as the now-dominant group of private traders, efforts were made in all three countries to strengthen warehouse receipt finance; most of the focus of these efforts was on export crops (coffee and cotton). If a warehouse receipt system is in place and banks have developed the skills to use it, it is technically relatively easy to extend its use across the range of commodities and even, manufactured goods. However, in practice, banks will remain risk-averse and will not easily enter into areas where there is political risk, e.g., maize finance.

Section 4.1 further discusses the topic of warehouse receipt finance and collateral management.

3.4. Country comparison

In all three countries, price and production risks appear high with a commonality of challenges faced. These include:

- High price volatility (with both high intra- and inter-seasonal variability)
- High climate risks (in all three countries, maize production is rain-dependent)
- Inefficient post-harvest handling
- Lack of information and poorly developed markets
- Difficulties of many producers and traders to deliver to quality standards
- Deficient storage and transportation infrastructure.

Nevertheless, there are differences between the countries. Kenya and Tanzania are in deficit or near self-sufficiency in maize, and therefore, prone to unpredictable policy interventions which are largely driven by short-term considerations. In Uganda, this risk is much less, and it is mostly linked to politically-driven market interventions in neighboring countries. Traders, and in particular exporters, face much

[35] A 2005 study (Pelrine & Besigye, 2005) refers to annual loans to commercial maize farmers, covering half of production costs, provided by Uganda's Centenary Rural Development Bank which cost 4 per cent a month – 2 per cent interest rates and 2 per cent monitoring costs. This compared to a 22 per cent annual interest rate for maize traders.

[36] See Salami et al., 2010.

more bureaucratic obstacles in Kenya and Tanzania than in Uganda. Those storing maize in Kenya and Tanzania run a real risk that the value of their maize gets suddenly eroded by a government decision to reduce import duties. In Uganda, price falls that result from political decisions are much less likely: the Ugandan government has explicitly stated that it will refrain from sudden market interventions, and exposure to any particular export market is limited as those storing maize always have the choice of selling into different markets. As a consequence of these factors, banks in Uganda are much more open to financing maize trade than banks in the two other countries.

Chapter 4
Risk mitigation methods

Farmers' response to risk depends on their ability to carry risk and the range of risk management tools available to them. Their ability to carry risk is, to a large extent, a function of their overall wealth, and the poorest farmers therefore tend to be the most risk averse. To the extent that traditional risk mitigation tools lead to reduced average incomes[37], then, exposure to risk is likely to perpetuate and reinforce rural income inequalities. "Avoiding high-risk investment choices can lock poor households into low-risk, low return production patterns, thus keeping them in a classic poverty trap."[38]

Most farmers in developing countries do not have access to formal risk management mechanisms, but instead rely on informal mechanisms to deal with risk. Farmers' strategies can be categorized into three broad categories[39]:

(i) prevention strategies. E.g., farmers can apply herbicides and pesticides or engage in crop rotation, to protect their crops from pests.
(ii) mitigation strategies, e.g. savings, crop diversification, or income diversification; and
(iii) coping strategies, to deal with the risk event after it has occurred, e.g. borrowing money or relying on aid from neighbours or relatives.

These mechanisms are valuable but cannot fully compensate for the lack of access to formal risk management markets. This chapter discusses some of these formal markets and how they could be used.

4.1 Warehouse receipt finance and collateral management

Poor maize storage contributes to maize market instability. As discussed in section 2.c.ii above, by using warehouse receipts and collateral management to link storage to finance, physical storage losses will be reduced, and seasonal storage will be encouraged.

The principles of warehouse receipt finance are simple:

(i) After harvest, the farmer, cooperative or trader delivers his maize to a licensed warehouse. If it meets certain quality parameters, it is accepted, and the warehouse operator will deliver either one warehouse receipt specifying the quantity, or two separate certificates (a certificate of title and a certificate of pledge). The former is more common in Common Law countries (i.e., English-

[37] "The costs of informal insurance against risk can be very high for poorer households.(…) Households in risk-prone semi-arid areas of India may have had to sacrifice as much as 25 percent of average incomes to reduce exposure to shocks." "Traditional systems might persist well after they are the best means for addressing problems. (…) In these cases, risk-mitigating mechanisms that are part of a household's own poverty alleviation strategy can turn out to be part of the problem.(…) There is a role for policy in fostering movement towards situations where poor households use more flexible mechanisms to address risk." (Morduch, 1999).
[38] Idem. "When a poor household does not have an effective strategy to insure itself against risks, this can send it into a catastrophic downward spiral into destitution. This causes the severity of poverty to worsen as already-poor households sink deeper into poverty and increases the prevalence of poverty as previously non-poor households fall below the poverty line. Shocks can also have non-catastrophic consequences for poor households that nevertheless cause them to suffer very high and often irreversible income losses." (World Bank, 2000).
[39] OECD, 2009.

speaking), the latter in Civil Law countries (i.e., French- or Spanish-speaking). However, while Kenya and Uganda have a single-receipt system, the warehouse receipt law that was introduced in Tanzania in 2005 specified a double receipt system.

(ii) The warehouse will release the stored maize only to the owner of the warehouse receipt in a single-receipt system, or the owner of both documents if there is a double receipt system.

(iii) The warehouse operator or an approved agent will also issue a quality certificate which has an expiration date – beyond this date, the operator takes no longer any liability for the quality of the stored crop, but until then, he is fully liable for both quality and quantity (after a small safety margin for possible weight loss due to the reduction of humidity of the stored maize).

(iv) When the depositor wishes to borrow against his crop, he transfers the warehouse receipt, or the certificate of pledge, to the bank as security.

(v) In a system with just one receipt, the farmer or trader can simply enter into a contract with a buyer; if he still has the receipt (i.e., he did not use it to secure a bank loan) he can endorse it to the buyer, inform the warehouse operator, and then the buyer can take delivery against the endorsed warehouse receipt.[40] In a double receipt system, the sale is through the sale of the certificate of title.

(vi) In the double receipt system, when the trader or processor needs the crop, he can redeem the certificate of pledge from the bank by repaying the original loan. The warehouse operator will then release the crop to the buyer against delivery of both certificates.

An electronic warehouse receipt system to manage all these steps (including the actual provision of the bank loans), as is operated in for example South Africa and Uganda, cuts costs, greatly facilitates the process, and strongly reduces risks for banks, traders, farmers and warehouse operators alike.

Collateral management is different in that the collateral manager is recruited (generally by the financing bank) to take temporary control over the warehouse where the goods that will act as underlying for the financing will be stored. The warehouse receipts will be transferred to the financier, and only the financier can authorize the release of (part of) the goods from the warehouse, either to the original depositor (e.g., in the case that processing operations are being financed, with both raw and processed material under control of the collateral manager) or a buyer.

Warehouse receipt finance and collateral management have a number of potential benefits. With farmers having the option to keep their product in a warehouse and use it as collateral for an affordable loan, they can avoid distress sales, leading to better price realisation, thus improved farmer income and in turn, more investments. By giving traders access to finance against the security of crop collateral, warehouse receipt finance reduces the pressure on them to rotate their stocks rapidly in order to maximize the use of their scarce capital; instead, they can engage in seasonal storage. Warehouse receipt finance improves stock visibility by location, which in turns leads to improved spatial integration domestically and regionally. As only well-managed warehouses will permit access to finance, the overall efficiency of food reserve management will much improve, ultimately improving the country's resilience to shock. Directly after the harvest, less product will flood the market and more will be moved into modern

[40] Endorsement is not necessary when the warehouse receipt is negotiable, but for security reasons (to provide a double check against falsification of warehouse receipts, for example) most warehouse operators and banks prefer to deal with non-negotiable receipts. In an Electronic Warehouse Receipt system, this is no longer a cause for concern.

warehouses (with modern drying equipment, proper pest control methods etc., and thus low storage losses), which leads to a structural reduction in intra-season price volatility. A sound warehouse receipt system, whether in paper form or (much more efficient) in electronic form, is an important support for a national or regional market.

As far as maize is concerned, progress in the three countries has been slow so far. In **Kenya**, there are separate pilots using paper warehouse receipts by EAGC and NCPB, with participation by several banks and traders. The Rockefeller Foundation has supported the creation of more than 20 cereal banks (a largely discredited concept in the rest of Africa[41]) owned by maize producers in western Kenya, which permit bulking of sales as well as local re-sale.[42] There is also some use of international collateral managers to manage maize flows in support of trade financing, particularly for imports by large maize millers.

In **Tanzania**, there has been a paper warehouse receipt system in place for several years under the management of the Tanzania Warehouse Receipt Licensing Board. It works quite well for export crops (cashew nuts, coffee): as of late 2010, 28 warehouses had been licensed, and eight crops approved for warehouse receipt finance; some US$ 90 million had been disbursed, and over 300,000 farmers trained.[43] Furthermore, international collateral managers are involved in providing credit support both for exports (in particular, coffee and cotton) and imports (mostly rice and fertilizers). However, warehouse receipt finance has hardly taken off for maize. This is partly due to government interventions in maize markets: a pilot project for warehouse receipt finance "has proved largely successful for paddy rice, but unsuccessful for maize, due mainly to farmers' difficulty in foreseeing price movements in a market subject to considerable Government intervention, notably export bans".[44] But even in the absence of government market intervention, maize is a difficult crop for warehouse receipt finance as there is no clear flow of the crop from producers in one location to consumers elsewhere – rather, most farmers are net buyers of foodgrains.

In **Uganda**, where a warehouse receipt law was adopted in 2006, an electronic warehouse receipt system is in place under supervision of the Uganda Commodity Exchange. Its main focus is on the coffee sector, but it also includes seven warehousing facilities for maize, linking to several financiers.

In all three countries, the implementation challenges are similar:

- Will the forward curve ensure sufficient price increase over the season to deliver positive returns to borrowers on the stored commodity? (In particular, some government interventions may flatten or make volatile the forward curve, and maize is very vulnerable to this risk)

[41] See Catholic Relief Services, Notes from the Workshop on Community-level Grain Storage Projects (Cereal Banks) - Why do they Rarely Work and What are the Alternatives?, Dakar, January 19-22, 1998.

[42] World Bank, 2006. Coulter, 2007, evaluated the performance of this cereal bank scheme and found that it was poor.

[43] Pascal, 2010.

[44] Coulter, 2009.

- Overcoming deficiencies in storage infrastructure – proximity to the producers of both the warehouses and the banks financing against warehouse receipts[45]; capacity bottlenecks; availability of grading and handling equipment
- Is the regulatory framework sufficiently robust to provide assurance to warehouses, borrowers and financiers?
- Can producers produce to defined quantity and quality standards? Can capacity building be extended to them?
- Will storage operators guarantee the warehouse receipts they issue?
- Will financiers finance a crop currently perceived as 'political'?

4.2 Contractual arrangements

Through their contractual arrangements for the sale and delivery of crops, farmers can shift certain risks to buyers. This is especially the case if they can become part of value chains wherein they receive loans to enable them to grow crops as per buyers' specifications, and where their sale (albeit not necessarily their sales price) is guaranteed.[46] Forward contract arrangements to this effect have started to be developed in East Africa. For example, outgrower schemes are increasingly used in Tanzania. They permit banks to provide loans to small farmers who otherwise would have insufficient collateral, on the back of a tripartite agreement in which a processor/trader commits to buy a farmer's crop and routes the payment through the financing bank to enable easy loan recovery.

Staple crops such as maize are typically not the most suited for contract farming or other forward contracting arrangements. This is because forward arrangements of any kind carry significant default risk, and one has to build strong risk mitigants into a transaction structure to manage this risk. For example, in the case of cotton, sugar or palm oil, the forward contract would typically involve delivery to the nearest processing plants; farmers who default on a forward contract will be deprived from access to this plant and will incur considerable costs to transport their bulky raw materials to a more remote plant – and they will carry this cost not only one season, but during many seasons to come. In the cases of fruits or vegetables, farmers who fail to deliver the contracted quantity into an organized supply chain have to sell on the informal market, where prices tend to be much lower. Forward sales contracts are normally also linked to the provision of inputs on credit, so that farmers who decide to side-sell their crop lose future access to input finance. It is very difficult to build similar risk mitigation elements into a forward contract for staple crops, as there are many different and easily accessible marketing channels, and price premiums for selling into the organized market tend to be low (except for niche products such as barley for beer production, or high-protein soyabeans for baby food production).

Nevertheless, in 2009, the largest commodity trading company in the region, the Export Trading Group, started a scheme of this nature for Tanzania maize farmers, with support from a number of development agencies and from Standard Bank. Under this programme, it provided maize seeds and fertilizer on credit to some 250,000 farm households (adding up to some US$ 50 million of credit). Credit reimbursement was through the delivery of maize. Farmers were guaranteed a minimum price for delivery to one of the

[45] Alternatively, banks can rely on an agency agreement with the warehouse operator which permits the latter to process the loan request (this system operates in India); combined with use of modern technology such as smart cards, automatic teller machines and/or mobile payment systems.

[46] See for a discussion of agricultural value chain finance Miller and Jones, 2010.

company's warehouses; Export Trading covered this risk though an over-the-counter put option written by Standard Bank. In principle, weather risk management can also be built into this kind of contract farming arrangements, and indeed, Standard Bank has started providing this facility in some African countries.

4.3 Futures and options

A futures contract specifies the exchange of a certain good at a future date for the pre-determined price set at the initial time of contracting. By using futures, farmers and others can lock in certain price levels independent of their physical trading operations. Options are risk management instruments that do not lock in prices but give protection against unfavorable price movements, with the possibility of profiting from favorable ones. Where they have access to risk management markets, farmers use these instruments to get greater control over and more flexibility in their marketing and pricing decisions, rather than just to reduce risk.[47]

However, the use of futures or option markets for risk management purposes is only useful if the prices of the markets for one's physical products and the futures prices are well-correlated. This is currently not the case for East African maize. The exchanges that offer maize futures contracts now, in South Africa and the USA, show price behaviour that does not well correlate with prices in East Africa. Trying to offset a local price risk exposure by buying or selling futures in South Africa or the USA, then, may be a futile exercise, as there is very little guarantee that, say, a price fall on the local market (which would lead to a loss) would be compensated by a profit made on the international market – one cannot reasonably expect that the two prices will move in tandem.

East African maize markets, then, need their own region-specific futures and option contracts. Rapid improvements in information and communications infrastructure in East Africa in recent years have made the introduction of such contracts possible; however, discussing the details of this falls outside of the realm of this study. Liquid maize futures and options markets will boost maize finance, and especially warehouse receipt finance, as banks can more easily evaluate and protect the value of collateral; the result should be lower interest rates and higher loans.[48] They will also support much wider use of forward contracts, as buyers will be able to lay off their price risks much more effectively. Fixed-price forward markets in an environment without futures carry very high default risk; in addition, the transparency and discipline imposed by a futures market will further reduce contractual risks. And in a competitive market, buyers who can lay off their price risk on an organized exchange will try to strengthen their competitive position by building various forms of price risk management into their offers to farmers – in Canada or the USA, for example, farmers can chose from a panel of over a dozen different pricing formulas built into spot and forward contracts.[49]

It should be noted, though, that even if new contracts are successfully developed, direct use by farmers is likely to be limited. For farmers (or any other entity) that are not well-integrated into the financial sector,

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[47] UNCTAD, 2002.

[48] Typically, the "haircut" that banks impose (the percentage of the market value of the goods that a bank subtracts for collateral purposes) is as much as 50% for a non-exchange traded goods, which can fall to just 10% for commodities whose value is hedged.

[49] See for example http://www.cargillaghorizons.ca/_documents/grain_contracts/prairies.pdf

using futures can be cumbersome: timing decisions are difficult to made, and cash flow requirements (to pay upfront margin depositions as well as later margin calls) can be demanding. Options are easier to use, but they can only exist if there is a strong underlying futures market. From the perspective of a farmer, options are similar to an insurance contract: he pays a premium to buy put options, and the "insurance" pays out when prices fall. Indeed, options can be used to replicate the price guarantee schemes abolished in recent years by many developing country governments. There are no margining requirements, and operational requirements are not overly complex. Futures and options are thus more likely to be used by larger entities, with farmers benefiting indirectly through better price information, more flexible sales/pricing options and more competition in both maize markets and agri-finance markets.

4.4 Weather index insurance

Index-based weather insurance instruments provide a payout to farmers when an index (e.g., rainfall during certain days, or maximum daytime or night time temperature, or more exotic data such as vegetation indices generated through satellite imagery) reaches a certain level – the payout to a farmer is not based on the specific loss that the farmer may have suffered. With such insurance, the farmer has some level of protection against a weather event that occurs in his region. This may be far from perfect – it may have rained where the weather station is located, but not on the farmer's fields[50] – but it is cheap to administer, and avoids the many problems (moral hazard, adverse selection) that come with farm-specific insurance programmes. [51] As a consequence, this form of insurance is more affordable than traditional insurance.

All three countries have had pilot index-based weather risk management programmes; the main constraint that has been found so far is the scarcity of functional weather stations and the lack of high-quality historical data. A preliminary assessment of weather risk insurance in Malawi, Kenya and Tanzania, which was built into an input finance program, comments that the offered contracts "appear to perform extremely well – so much so, that demand in many places has overwhelmed administrative capacity to serve clients. In interviews, farmers have stated that their primary strategy for adaptation to climate change is enrolment in the insurance program."[52] A willingness-to-pay analysis of weather insurance in Tanzania found that "Were the premium to be set at the actuarially fair value, about 10 to 18 percent of all rural households in Kilimanjaro would insure about 28 000 to 87 000 acres (about 6 to 17 percent of total land cultivated) resulting in a consumer surplus or benefit to society of more than 300 million Tsh or 300 thousand US dollars."[53]

Index-based insurance protects farmers from risks, and also enhances their access to credit which should lead to improvements in production. Also, agricultural banks can bundle weather risk management with their loan packages (for example, loans are forgiven if there is a drought, and the bank claims its money back from an insurance company), or they can insist that lenders take out weather insurance with the

[50] This "basis risk" is much less in the case of insurance against catastrophic events such as droughts (whose effects tend to be uniform across a large area) than for more frequent events, e.g. rainfall that is 10 per cent less than normal. This is among the reasons for Skees, 2008, to advocate "not to create weather index insurance for events that occur more frequently than 1 in 6 or 1 in 7 years."

[51] Varangis, 2001.

[52] Osborne et al., 2007.

[53] Sarris et al., 2006.

eventual claims payable to the bank, or they can insure their agricultural loan portfolio against weather-related default risk.[54]

4.5 Illustrations of operation and impact of market risk mitigation instruments

4.5.1 Experiences with price risk management in the East African coffee market[55]

East Africa's coffee producers and traders, and the banks financing them, have long recognized their exposure to price risk. To reduce its trade finance risks, in 1994 a regional bank, the Eastern and Southern African Trade and Development Bank (PTA Bank) started a "Price Guarantee Contract Facility", under which it built price risk management into its coffee and cotton post-harvest trade finance operations. Many seminars were held in eight of its member countries, and a number of exporters and processors in Tanzania and Uganda signed up to the new facility, as did one or two farmers' cooperatives. But the price guarantee programme faded away in the second half of the 1990s, largely because risks other than price (resulting from poor control over export logistics, in terms of quality, quantity and timing) were found to be much more significant for the bank.

A renewed effort was made in 2000-2002, as one of the pilot projects initiated by the International Task Force on Commodity Risk Management (convened by the World Bank). Tanzania's largest cooperative, the Kilimanjaro Native Cooperative Union (KNCU), with several thousand members, was supported in developing a price risk management programme. It was exposed to large price risks between the moment that it announced its minimum purchasing price to its farmers, and the moment when it sold its coffee through Tanzania's coffee auction. The first transaction came in 2002, when it bought options for 700 tons of coffee (some 15% of its normal trade volume). These were average price options, provided by Rabobank, a Dutch bank. The Know-Your-Customer requirements of this bank led to very high transaction costs, and without support from the Task Force the KNCU-Rabobank relationship would not have been possible. KNCU's coffee trade was being financed by a local bank, the Cooperative Rural Development Bank (CRDB). CRDB was not only willing to finance the option premiums, but also, to reduce the interest rates on its loans on the condition that KNCU managed its price risks. The option strategy was designed to allow the cooperative to maintain its practice of guaranteeing a minimum price to its farmers prior to harvest, and make subsequent payments if realized sales prices turned out to be higher. The first transaction led to a pay-out; this, and strong encouragement from CRDB, led to KNCU entering into four subsequent transactions, for a total of some 40% of its coffee sales.

But the risk management strategy failed to take firm root in KNCU: it did not hedge its exposure in any of the following years – despite the fact that the value of its coffee inventory could change by as much as a million US$ in the course of a few weeks. Changes in the management of the cooperative played a role, as well as an opportunistic attitude of the cooperative's new management: they did not believe prices would fall, so why pay money for option premiums? CRDB, however, has internalized the provision of price risk management: in 2004, it introduced commodity put options as part of its core product offer in 2004, under the name of "Kinga Ya Bei" (price insurance). At least one other coffee cooperative has since used this new product, while another coffee cooperative has directly bought options through a New York brokerage.

[54] BASIX, a micro-finance NGO in India, has done this. See Scott, 2005.

[55] Primarily based on Rutten & Youssef, 2007. See also Bohay, 2006; and Scott, 2005.

This experience brings out a number of useful lessons. Farmers and farmers' leaders may recognize the extent to which they are exposed to price risk, but their actual risk management decisions are likely to remain opportunistic, with price expectations affecting their willingness to hedge. Building risk management at the cooperative level is not necessarily the answer. Linking an East African cooperative (or for that matter, company) with a western risk management market is not easy, and given stringent Know-Your-Customer rules governing OECD banks and brokers, the fixed costs of setting up a relationship will be high. But involving banks financing commodity production and trade is likely to bring greater sustainability, if these banks become convinced that they can add a risk management product as merely another part of their offering.

4.5.2 The particular case of grain markets – a case study from India

Wheat futures were launched on India's National Commodity & Derivatives Exchange (NCDEX) in July 2004. One of the first large users was Hafed, the Haryana State Cooperative Supply and Marketing Federation. Hafed is an apex cooperative institution of farmers established by the Government of the State of Haryana, with a mandate to procure wheat and other commodities under the national "Minimum Support Price" scheme, and to buy agricultural commodities from, and supply inputs and credits to farmers in the State. Hafed basically used the NCDEX wheat contract to protect its margins.

Hafed started small, but rapidly increased its operations; and also expanded its coverage to mustard seed, another important crop in the State. It convinced NCDEX to accredit its warehouses as delivery points, permitting it an easy choice between closing out its futures position through an offsetting financial transaction, or closing it out through delivery from one of its warehouses.

Hafed staff rapidly built up the expertise for successful hedging on the futures market. It was able to lock in the high profit margins possible on seasonal storage: instead of immediately selling the wheat it bought in the April and May harvest months, Hafed stored it, simultaneously sold December futures contracts to protect itself against the risk of price declines, and then unwound the transaction towards the end of the year. In addition, because of the flexibility that the futures contracts gave it, Hafed did not have to do any distress selling.

Hafed made significant profits thanks to its ability to sell its wheat and mustard seed more flexibly while protecting itself from downward price risk. It also benefitted indirectly, by getting better market information, and because it was encouraged to improve its quality assurance practices: to meet the requirements of the exchange's accreditation process for its warehouses, it had to improve their management and install proper assaying equipment. Hafed was so motivated by the success of its hedging operations that it obtained government permission to start acting as an 'aggregator' (broker) for farmers. But the Indian government's ban on wheat futures in 2007 threw a spanner in the works.

In late 2006, the government became concerned about food price inflation, and decided it had to be seen to do something. The futures markets, which acted as messenger for the increasingly tight supply/demand conditions in global and local food markets, were an easy target. On February 27, 2007, India's commodity futures market regulator, the Forward Markets Commission, banned the introduction of new wheat and rice futures contracts and directed that all open futures positions be eliminated. This led to significant losses for many market participants who had hedged their positions. Wheat futures were reintroduced in May 2009, but with the experience of 2007 in mind, market participants were hesitant to return to the futures market, and volumes did not return to the pre-2007 levels.

Hafed studied the possibility to use the international wheat futures market (at the Chicago Board of Trade, CBOT – now part of the Chicago Mercantile Exchange), but found that the prices that it realized in India and Chicago prices had too little correlation. In late 2010, Hafed started considering the use of Indian wheat futures again, even though volumes were still low in comparison with the volumes in which Hafed habitually traded.

The lessons of this is that a farmers group can learn quite rapidly how to use grain futures in a sound and sustained manner; but that when it comes to food commodities, even a contract which operates well and has proven its usefulness to physical market participants is vulnerable to politics in times of price inflation.

4.5.3 Weather index insurance for Malawi's groundnut and maize farmers[56]

Malawi farmers can much increase their yields if they use higher quality seeds and more fertilizers. The costs of these inputs would normally be easily covered by higher revenue from crop sales. However, farmers are constrained in their ability to self-finance these inputs while financiers find it too risky to lend to them. And not without reason. Malawi's banks used to have recovery rates for loans to farmers in the 50-70% range, and in the early 2000s, major government and donor lending programmes lost half of their value in just five years. Drought was a major reason for farmers' loan defaults.

This problem was addressed head-on in a pilot project for groundnut farmers that was launched in the 2005/2006 season. The project worked as follows:

1. The National Smallholder Farmers' Association of Malawi (NASFAM), the Insurance Association of Malawi and two lenders entered into a framework agreement
2. Farmers who committed to sell their groundnuts through NASFAM received improved groundnut seeds on credit; they also became the beneficiary of a weather index insurance facility (which accounted for some 6-7% of the loan value). Insurance covered the full value of the seeds.
3. NASFAM bought the corresponding coverage from the insurance company, using part of the loan provided by the lenders.
4. When farmers delivered the groundnuts to NASFAM, their loan reimbursement, net of the eventual payout from the index insurance, was deducted from their payments. NASFAM collected the payouts from insurance directly. In case of a full payout, NASFAM did not deduct any amounts for seed costs from the payments made to farmers.

The technical design of the project was complex and required significant World Bank support. Contracts were designed to start providing payouts – equivalent to the input loans, not the crop loss – for moderate yield declines. The insurance was not designed just for catastrophic risks. Participating farmers had to be within 20 km of a weather station to participate. In 2005/2006, 892 groundnut farmers purchased weather insurance paying some 35,000 US$ in premiums. The number of groundnut farmers increased to 1,710 the next year, and another 826 farmers purchased index insurance for maize production. Rainfall was

[56] Based on Osgood et al, 2007; Syroka, 2007; and Skees, 2008.

good and no claims were paid. Groundnut farmers reported a yield increase for hybrid seed of 140 percent. In 2008, 2,600 farmers bought weather index insurance for a total sum insured of 2.5 million US$.

The pilot served in bringing banks back into agricultural lending, but this time, directly managing the default risk associated with droughts. The main problem faced in the initial stage, when the programme was focussed on groundnut farmers, was that of side-selling by farmers, so that they could avoid meeting their loan obligations.[57] The banks participating in the pilot concluded that weather insurance would work better if it was used for crops with stronger supply chains (e.g., contract farming arrangements) such as tobacco, paprika, tea, coffee and cotton. In 2007/2008, the programme thus shifted to tobacco farmers.

One of the South African banks that was involved is now rolling out the product (input credit bundled with weather and price risk insurance) in other African countries, as part of large programme of the Alliance for a Green Revolution in Africa.

4.5.4 Market institutions as a tool for government price policy – Indian examples

The Indian government intervenes actively in a number of agricultural commodity markets, including those for cereals and cotton, generally trying to balance the interests of producers and consumers. Its traditional mode of operations, though, is characterized by large waste as well as an inability to reach households in many regions.

In the past few years, efforts have been made to use private sector structures to remedy these problems. In particular, government bodies such as the Food Corporation of India (FCI) and the National Agricultural Marketing Cooperatives Federation of India (NAFED) are now “outsourcing” some of their procurement and distribution activities to the private sector. Among their main agents have been the National Spot Exchange (NSEL, an electronic market; NAFED is a shareholder) as well as the National Bulk Handling Corporation (NBHC, a collateral management company).

NSEL’s core business is the provision of an electronic commodity spot market to buyers and sellers. A farmer typically brings his crop to the nearest NSEL warehouse – well over thirty agricultural commodities, including cereals, pulses and oilseeds, are currently traded. At the warehouse, his product is tested for quality. If it qualifies for sale on the NSEL[58], the farmer instructs his broker (the member of NSEL) at what price he wishes to sell, and the broker enters this price on the exchange's terminal. The goods are stored in the warehouse until there is a buyer. NSEL has arranged credit lines with banks that permit the farmer to obtain low-cost credit against the collateral of his goods in the warehouse. Once there is a buyer, the farmer is paid at once (after reimbursement of the bank loan, if applicable). In the case of NBHC, its core business is providing support to commodity finance. A farmer (with maybe just one bag) or a trader deposits goods in one of NBHC’s 3,000+ warehouses, and if the quality is acceptable, NBHC staff then arrange a loan from one of the 40+ banks from which it has a mandate to arrange such

[57] Hazell et al., 2010.

[58] NSEL, like NBHC, has rather stringent quality requirements. Many farmers are still found to deliver crops that do not meet these requirements, e.g. in terms of humidity. In such cases, farmers sell to middlemen who then dry or otherwise treat the crop.

agri-loans. The funds arrive in the client's account the next day. In both cases, the warehouse networks can serve government programmes.

In the case of government procurement (e.g., under India's Minimum Price Support programme), the buyer determines the region of intervention, his quality requirements and his price (for delivery into his warehousing infrastructure). NSEL and NBHC then open rural warehouses where farmers and others can deliver their crop, offering a price based on the official price corrected for transport, processing and handling costs. Several other organizations have also taken to using NSEL to auction off food commodities – e.g., FCI arranges part of the wheat sales under its Open Market Sale Scheme through tenders on the NSEL platform. Private sector operations such as these effectively extend not just the benefits of modern trade and finance to India's rural masses, but also, extend the reach of government policies that are meant to protect producers or poor consumers.

Chapter 5
Trade policy as an instrument for risk mitigation, the East African scenario

In both Kenya and Tanzania, governments use trade policy as a tool to influence prices on maize markets. In Kenya, and to a lesser extent Tanzania, they also use marketing boards for this purpose. Both countries have normally high import duties for imports from outside the region which are reduced or eliminated when governments see fit, and both use export bans when they feel that there is a local maize shortage. In both countries, there are also a number of non-tariff barriers (including a ban on GMO maize), with cumbersome import/export procedures. Intervention, where it occurred, was undertaken broadly to balance between three socio-economic goals: remunerative farmer income, food security/consumer protection, and protecting producers and consumers from excessive price volatility.

Uganda has stable trade policy when it comes to maize (the only significant barrier to trade is a ban on GMO maize), and does not operate a marketing board, or even a Food Reserve Agency. In effect, Uganda's Plan for Modernization of Agriculture says: "The Government recognises that publicly held food reserves are very expensive under the best of conditions and require careful management to minimise losses due to spoilage. Such schemes have had limited success in other countries, but have certainly exerted substantial demands upon public funds. Therefore, government will not adopt any policy to accumulate such stocks unless and until careful studies in Uganda have determined their efficacy."[59] But while there is no government intervention, the role of the World Food Programme has been large.

The tables on the following pages reflect the scenarios in the different countries, as well as the viewpoints of market stakeholders on key policy issues. These tables summarize the views expressed by maize market stakeholders in Kenya, Tanzania and Uganda during interviews with the project team in the spring of 2011.

[59] Quoted in Minot, 2010b.

Table 30

Maize markets, risks, market interventions and market-based instruments: Kenya

Country Scenario	**Risks**
• Maize is the most important food staple – some diversification on production side, but 'most farmers grow at least some maize' • Ordinarily deficit, sometimes close to self-sufficiency, but generally a net importer from the region (mainly ex-Uganda) • In poor harvests, or drought situations, imports - sometimes in significant volume – required from outside the region (typically US, RSA)	• High price risk, with both intra- and inter-season variability, lack of information and markets • High production risk –agriculture is rain-dependent, high post-harvest losses, delivery to standards, infrastructure deficiencies, lack of information • High financial risk – banks wary to finance • High institutional risk – NCPB intervention fuels price variability; import duty variability; alleged NCPB payment delays
Interventions	**Market-Based Instruments**
• NCPB intervention through procurement/price-setting, food reserve, sales and distribution • High but variable import duties and export limitations • Non-tariff barriers / entry port delays • Prohibition on GMO maize (but not in the manufactured product)	• RATIN / FEWSNET / KACE as market information systems • Two nascent warehouse receipt systems piloted by EAGC and NCPB, financed by several banks • Project towards Comex development, under NCPB auspices • Weather insurance ('kilimo salama') in its infancy.

Table 31

Key interventions – the viewpoints of Kenyan stakeholders

Intervention	**Positive Perspectives**	**Critical Perspectives**
Import duty levels, and periodic reduction of such duties at times of shortage	• Protects farmer incomes by keeping out flows of non-regional maize • Supports prices on the upside to incentivise increased production • Under COMESA and EAC agreements, imports are still allowed duty free access from the region	• High duties prevent pre-emptive shipments that would allow early aversion of food security crises (exacerbated by bottlenecks at port) • Unpredictability of decision-making causes sudden price falls, deterring storage and forward contracting • The low import duty window has been left open too long in the recent food crisis, depressing local markets • Regional imports sometimes excluded due to non-tariff barriers, albeit informal flows still come in.
NCPB procurement/ price-setting, food reserve, sales and distribution activities	• NCPB's procurement, storage and sales help to cap prices on the upside (to help protect consumers) and on the downside (to remunerate farmers) • NCPB's food reserve management is critical in ensuring food cover for deficit areas for 2-3 months • NCPB procures a small proportion of total production, therefore can expect low level of influence on market price • NCPB is a technical actor that carries out a mandate assigned by political actors – and seeks to do so in a way that minimises market disruption.	• NCPB decision-making is unpredictable, deterring the use of storage and the development of forward contracting, which in turn exacerbates volatility *(as the NCPB price is a major signal for the market it has a disproportionate impact on stakeholders' marketing decisions)* • NCPB decisions – especially price setting – are driven more by funds availability and procurement targets than the goal of adequately remunerating farmers • NCPB takes up to 6 months to remunerate farmers, reinforcing farmer susceptibility to 'predatory middlemen' that offer cash on collection • NCPB decision-making can be too politicised • Slow government decision-making in food security crisis exacerbated uncertainty and shortages.

Table 32

Maize markets, risks, market interventions and market-based instruments: Tanzania

Country Scenario	**Risks**
• Maize is the most important food staple – some diversification on production side, but 'most farmers grow/should grow some maize' • Self-sufficient, but internal surplus and deficit areas – surplus areas prefer to serve attractive markets cross-border but prevented from doing so leading to informal cross border trade; deficit areas struggle to get sufficient maize (despite export bans) due to distribution bottlenecks.	• High price risk, with both intra- and inter-season variability, lack of information and markets • High production risk –agriculture is rain-dependent, high post-harvest losses, delivery to standards, infrastructure deficiencies, lack of information • High financial risk – banks wary to finance • High institutional risk – export bans; crop tax/ cess; 'bureaucratic procedures'; NFRA activities (relatively minor impact).
Interventions	**Market-Based Instruments**
• Reconstituted NFRA still establishing its role in procurement, food reserve, sales and distribution (working with private sector) • Export duties and 'bureaucratic licensing' • Prohibition on GMO maize (but not in the manufactured product) • Crop tax and 'bureaucracy' at local level.	• RATIN / FEWSNET as market information systems • Warehouse receipt system operational for some commodities but not maize, financed by several banks • Project towards commodity exchange development, under CMSA auspices • No known crop insurance programmes.

Table 33

Key interventions – the viewpoints of Tanzanian stakeholders

Intervention	**Positive Perspectives**	**Critical Perspectives**
Export Bans	• To keep food inside the country to feed Tanzania's food deficit areas ('we must feed our children before those of our neighbours') • Ease political pressures as food insecure populations see that 'something is being done'.	• Depresses maize price and discourages maize production as export bans exclude access to attractive markets cross-border, thus exacerbating Tanzania's food insecurity • The policy is ineffective as (i) surplus food is unable to be shifted to deficit areas due to poor infra-structure, (ii) volume is still shifted cross-border through informal flows, but in this case the value is often not realised by farmers • Impairs food security in other regional markets
Local Crop Tax/Cess and 'Bureaucracy'	• To funds local and central government structures • To helps government maintain visibility into and control of the sector for the benefit of the country.	• Crop tax – as well as the bureaucracy in marketing and export – disincentivises production and reduces farmer income, exacerbating food insecurity • Applies irrespective of harvest conditions – thus exacerbates vulnerability of farmers who must pay even when the harvest is poor • Creates and encourages opacity in the market, exacerbating spatial and temporal price distortions • Favours 'insiders' who are better able to navigate the bureaucracy and/or receive better treatment, to exclusion of smaller scale actors including farmers.

Table 34

Maize markets, risks, market interventions and market-based instruments: Uganda

Country Scenario	Risks
• Maize is not the most important food staple –high diversification on production and consumption side, but in both aspects identified as becoming more important • Surplus producer – exporting, through private sector and WFP channels, to regional markets • Some deficit areas in Uganda dependent on WFP distribution – both for Ugandans, IDPs as well as refugees	• High price risk, with both intra- and inter-season variability, lack of information and markets • High production risk –agriculture is rain-dependent, high post-harvest losses, difficulties in meeting standards (especially, poor drying). infrastructure deficiencies, lack of information • Medium financial risk – banks starting to finance, maize considered 'less political' than in Kenya and Tanzania • institutional risk comes mainly from policies of other countries in the region
Interventions	**Market-Based Instruments**
• Minimal interventions by Government of Uganda • The evolving role of WFP in procurement, storage and distribution was noted and discussed, sometimes taking more than 10 % of market, higher share of standardised product • Prohibition on GMO maize (but not in the manufactured product)	• RATIN / FEWSNET as market information systems • Warehouse receipt system operating under UCE auspices, financed by several banks • UCE as a constituted comex - focus on WRS to date, varying opinions as to its efficacy in trading operations • No known crop insurance programs

Table 35

Key interventions – the viewpoints of Ugandan stakeholders

Intervention	Positive Perspectives	Critical Perspectives
Liberalised Market Structure	• Has enabled the growth and development of the Uganda maize sector to serve regional markets, as well as a source of humanitarian food supplies • Has avoided significant spatial and temporal price distortions, and the 'flaws of neighbouring countries'	• Has deprived farmers of important extension services, especially on effective drying and cleaning techniques, and appropriate use of inputs • Uganda needs a food reserve agency that will backstop food security as well as protect farmers and consumers from the extremes of food price volatility
WFP Procurement, Storage and Distribution Activities	• WFP activities have helped address and ameliorate humanitarian crises in Uganda and neighbouring countries over many years • WFP activities in Uganda have created demand for Ugandan product, in turn creating jobs and sustainable income • WFP has evolved in line with development thinking, and is adapting structures and processes e.g. P4P that are more farmer friendly and supportive of market formation/ development	• WFP has inhibited formation of food markets in Uganda through non-commercial procurement, storage and distribution activities, making a commercial storage sector unviable, preventing transparent price discovery, and reinforcing the market power of an 'insider club' of 'eligible traders' who can perform to WFP tender process • WFP has enabled countries outside the region to dump surplus product into the region, depressing local markets

Chapter 6
Proposal for risk management mechanisms

Grain market stakeholders in East Africa have definite ideas, which are largely similar country-to-country, on what needs to be done to improve the grain sector in the region. The continuation of existing policies does not figure among their recommendations. Table 36 summarizes the strategic opportunities as identified by them.

Table 36
Strategic priorities as identified by regional grain market stakeholders

Structured Trading	Market Information	Policy and Standards
Warehouse Receipts System	Integrated Regional MIS Platform	Intra-Regional SF Tariffs
Regional Commodity Exchange	Leverage Existing National Systems	Marketing & Price Controls / Export and Import Restrictions
Regional Marketing Infrastructure	Ensure Data Integrity and Quality	Staple Foods Quality Standards
Collateral Management	Effective Data Dissemination	SPS
Contract Enforcement and Dispute Resolution	Drive Use of Market Information	Regional Food Security and Nutrition Policy
		Non-Tariff Charges

Source: Report – Regional Staple Foods Trade Workshop, 8 Nov 2010 – Entebbe, Uganda (organised jointly by EAGC, ACTESA/COMESA, EAC, USAID COMPETE, AGRA)

In the policy area, grain market stakeholders hope for regional rather than national policies; and they stress the importance of the government setting and enforcing common standards, including for quality, and sanitary and phytosanitary standards.

All stress the importance of better market information, from the need to improve the basic quality of information to the dissemination of data; and again, they stress the need for a regional rather than national perspective.

Stakeholders also recognize the need for a series of policies and actions in what is often called “structured trading” in East Africa: making value chains, from farm to fork, more reliable; and improving the support system for these value chains, in particular through an improved warehouse receipt system (which in turn can underpin greater use of collateral management) and a regional commodity exchange. It is these latter actions which will be discussed further in the next section. Then, the final section describes what it implies for trade policies if governments wished to see the effective development of support systems for maize value chains.

A useful approach to maize price volatility is to consider it as a result of the shape of supply and demand curves.[60] External shocks are inevitable, but it is the shape of the curve that determines the price response to such shocks.

Price volatility can be reduced by making supply and demand more elastic. On the supply side, while the domestic supply response will remain slow, elasticity of supply can be improved by creating better extension services and input supply. The other main component of supply, imports, can however be made more elastic by removing uncertainty about future maize import duty levels and concerns about possible subsidized sales by government marketing agencies. Furthermore, improving the elasticity of demand in itself will encourage investments in supply, as farmers will be less fearful of sharp future price falls.

On the demand elasticity side, several measures can be considered:

- Improving physical infrastructure, particularly roads. With lower transport costs, the size of the market for any particular farmer grows, and thus demand becomes more elastic.

- Stimulating regional trade. This expands the size of the market. Moreover, as supply, in the short run, is mostly driven by weather and weather in the different countries can differ significantly,, the overall volatility of supply in the market will be less and thus, price volatility.

- Streamlining regulations and trade barriers. The barriers themselves as well as their unpredictability create unnecessary costs and hinder the role of regional arbitrage in helping to reduce the impact on localized supply or demand pressures.

- Improving financial markets to improve traders' capacity to absorb surplus production – both directly (by promoting warehouse receipt systems) and indirectly (by refraining from government policies that discourage private sector storage). This permits better seasonal arbitrage, reducing price volatility both for producers and consumers.

- Diversification of food consumption, as has been happening in East Africa with the growth of cassava production. This helps consumers to shift from maize to other foods if relative maize prices increase, and vice versa.

6.1 Possible market-based value chain support mechanisms

Elements of market-based value chain support mechanisms exist in the region. Information systems have been established in the 1990s which collect and disseminate maize market information, and largely through donor support, continue operating. But other than RATIN and FEWSNET MIS they are national rather than regional in focus. In Kenya and Tanzania, there are modern grain warehouses/silos, often built with donor support. Donor support has also driven the development of warehouse receipt systems in all three countries – although they are being used at varying levels of scale and sophistication. A

[60] The discussion below is based on T.S. Jayne, Anthony Chapoto and Jones Govereh, Grain marketing policy at the crossroads: challenges for Eastern and Southern Africa, in Sarris and Morrison (eds.), 2010.

commodity exchange exists in name in Uganda (it focuses on operating the country's warehouse receipt system), although stakeholders held varying opinions as to its efficacy in trading operations. In Kenya and Tanzania, there have been talks on the establishment of commodity exchanges.[61] Weather index insurance, initially for maize farmers but since expanded to other crops, was established in Kenya in 2009 (the 'Kilimo Salama' scheme[62]) and is being piloted in Tanzania and Uganda, but it is still in its infancy.

With respect to warehouse receipt finance and collateral management, much progress is possible in the maize sector. In Kenya and Tanzania, however, this will require government action (or rather, a government commitment not to act arbitrarily in maize markets). In Uganda, it needs a more comprehensive approach that treats maize warehouse receipt finance and collateral management as a component of regional maize value chains.

Market-based price risk management in East Africa's maize sector is difficult because the markets to manage such risks efficiently do not exist. Maize price behavior on South Africa's futures exchange, SAFEX, or the CME in the United States, is so different from that in East Africa that taking positions in either does not provide much protection against month-to-month price movements in East African markets. So not surprisingly, there has been much talk about setting up a national or regional commodity exchange. The benefits of this are clear. It would provide access to risk management tools, especially for maize's myriad small-scale farmers. It would engender more efficient price discovery – spatial and temporal integration of prices domestically, regionally and internationally. It would lead to more transparent price and market information – including as a reference for negotiations with middle-men and giving farmers visibility on premium for higher quality crop to encourage investment/input use. It will act as a catalyst for improving quality standards and contract performance. And it will be possible to introduce instruments that are specifically tailored to the regional market.

Exchange technology and communication and payment links in much of Africa have improved enough in the past few years to make African spot and futures exchange initiatives viable – weak trade and finance infrastructure is no longer an insurmountable obstacle. Nevertheless, such initiatives still face multiple implementation challenges. Is the regulatory framework sufficiently robust to ensure market integrity, systemic stability and investor protection, per international standards? Will the warehouse receipt system and the physical delivery network function robustly and efficiently to guarantee quantity and quality of the delivered commodity, and provide effective access to commodity chain players? Is the technology and domain expertise available on the right terms (combining a high level of performance with affordable cost) to provide the envisaged commodity exchange solution? Is the liquidity potential sufficient in each country or in the region as a whole to create efficient commodity exchange-based procurement, delivery, financing, hedging and investment (as applicable) markets at an affordable level of transaction cost? Can

[61] Kenya has its Kenya Agricultural Commodity Exchange (KACE), created in 1995 to provide a platform for organized commodity trade (using a trading floor as well as electronically linking buyers and sellers). But this intended business did not take off, and KACE now functions as a donor-funded price information service.

[62] Farmers can buy "Kilimo Salama" weather insurance through their cell phones, in the same stores where they buy their seeds, fertilisers and chemicals. At the end of the growing season, payouts go electronically to the farmer's cell phone account – this is entirely linked to the rainfall at the weather station to which a particular farmer is linked, there is no need to make any claim. Half of the insurance premium is subsidized, with support coming from companies such as Syngenta.

producers produce to defined quantity and quality standards? Will government align their interventions regimes (as applicable) to ensure compatibility with the functioning of an orderly, competitive and transparent exchange-based market? Will a commodity exchange offer sufficient added value to private sector to justify often-expensive changes to established business processes and market structures?

Conditions for grain trade are improving throughout Africa, and the effects of this are measurable in terms of better spatial market integration as well as declining marketing costs.[63] This enhances the prospects of new grain futures contracts tailored to the region. However, maize is probably not the best "first priority" for a prospective commodity exchange in East Africa, given how politically sensitive the crop is in Kenya and Tanzania.[64] Investors are unlikely to expose themselves so strongly to political vagaries, given the track records of governments in the region. A more broad-based exchange, trading a range of agricultural and non-agricultural commodities as well as other financial assets, will be less vulnerable to such risk.

6.2 Leveraging the power of the market through an appropriate trade policy framework

Assume that the governments of Kenya, Tanzania and Uganda have three objectives in their maize price policy: ensuring that farmers get the best possible price; ensuring that consumers pay affordable prices; and protecting producers and consumers from excessive price volatility. This section discusses a trade policy framework that leverages to the extent possible on the potential of market-based instruments in order to reach these objectives.

This trade policy framework requires several components:

- policies and supportive actions that permit market instruments to operate at their best;
- safety-net mechanisms for, on the one hand, producers, and on the other consumers;
- policies that ensure that the transaction costs from farm to fork are as small as possible, to reduce the inherent tension in the otherwise conflicting objectives of protecting both producers and consumers; and
- mechanisms to influence price volatility by either reducing transmission from international markets, or directly intervening in domestic maize supply/demand.

Policies and supportive actions to support market-based instruments

The market-based instruments discussed in this report – warehouse receipt finance; forward contracting between farmers on the one hand and processors, traders or supermarkets on the other; futures and options; weather index insurance – can all help market participants to better deal with risk and enhance their welfare. But considerable institution-building is required for these instruments to reach their potential. Governments, with the support of donors, should strive to support the following:

(1) The development of an effective system of maize grades and standards
(2) The strengthening of the legal system, to permit those involved in maize trade to have trust in the integrity of contracts and their ability to enforce them

[63] Tschirley, 2009.
[64] Winter-Nelson, 2010.

(3) The creation in Kenya and Tanzania of a national electronic registry/depository for warehouse receipts, as already is operational in Uganda. In due time, this can be expanded to incorporate the registration of the assignment of collateral and of receivables – which would support the introduction of instruments such as Rural Product Notes, the main pre-harvest financing mechanism of Brazilian farmers.
(4) A transparent, competitive licensing regime permitting private sector companies to become involved in the provision of warehouse receipt finance, futures, options, and weather risk insurance.
(5) A supportive policy framework for such instruments and the institutions that provide them, including possibly financial support for piloting new approaches, awareness-raising and education, and institutional start-up costs. Donor agencies should build on existing programmes to provide partial guarantees for new forms of finance in order to further support the development of strong institutions for warehouse receipt finance and collateral management.
(6) A removal of legal and regulatory constraints to the effective functioning of market-based instruments.
(7) A commitment to rule-based rather than discretionary intervention in maize markets, both as concerns domestic trade and imports/exports.
(8) A reform of WFP procurement operations so that they strengthen private sector capability as well as market infrastructure. WFP procurement currently distorts markets and does little to strengthen them. WFP should make a forceful commitment to buy, wherever possible, using warehouse receipt systems and electronic exchanges, similar to the ways in which state entities in India operate. It should also start accepting warehouse receipts issued by reliable warehouse operators instead of performance bonds. There are no risks or downsides to such an approach (at least not for WFP – the warehouse companies/exchanges are exposed to risks of delays in WFP payments). WFP's current reticence in this regard should be addressed in the light of East African countries' overriding interest in seeing a healthy development of their grain markets.

To properly prioritize activities and ensure sound implementation, the government should intensify its interaction with the private sector, giving it an important role in deciding on strategies and specific measures.

Safety-net mechanisms

It is perfectly legitimate for governments to wish to provide countercyclical safety nets for the poor, whether they are producers or consumers (in Africa, most farmers are actually net food buyers). Given budget constraints, it is however essential that they adopt cost-efficient approaches that reduce leakage and administrative costs to the minimum.

There are several possible mechanisms for the government to provide a safety net to **sellers** of maize:

(1) A government agency (e.g., a buffer stock) can buy at a guaranteed price. There are four main issues with such a price support programme:
    - Given the political pressures to which a government agency is normally exposed, how can it buy at a price proper to a specific location rather than offering one pan-territorial price (which stimulates inefficient production and weakens market institutions)?

- How does it get sufficient reach? Using private sector entities, in particular a commodity exchange or warehousing companies/collateral managers (as is done in India, section 3.5.4) is likely to be the best way of ensuring wide reach. It would also help ensure that the prices offered reflect the specifics of each location.
- How can one ensure efficient storage? Government companies often suffer from high storage losses.
- How does one sell the maize bought in a surplus year without disrupting the market? Organizing electronic tenders is probably the best way.

(2) The government can create a warehouse-based programme to provide minimum prices, similar to that which was operated by the Commodity Credit Corporation (CCC) in the USA for a range of commodities. Farmers (and in the case of sugar, processors) could deposit, say, sugar into a warehouse, and obtain a loan from the CCC using as collateral their sugar valued at the official "support price". Later on (within at most nine months), they could either sell the sugar on the market and repay their loan; or if market prices were unfavourable, they could forfeit the sugar in full satisfaction of the loan. Forfeited commodities could be resold at market prices, released to the market once a certain trigger price level is reached, or exported under an aid programme. [65]

(3) A government agency can offer risk management contracts (in a form that resembles price insurance) to farmers or farmers' associations, bundling the resulting risk and laying it off on the international market (or a local exchange, once there is one). This model has been used in Mexico. In the early 1990s, the Mexican government decided to scale back its interventions in agricultural markets, abolishing both its support prices for a number of crops, and its subsidies to maize prices. Instead, if offered farmers and maize mills access to subsidized put and call options on Chicago maize prices. This form of intermediation is currently not feasible in East Africa, but may be worth considering once there are liquid region-specific maize futures contracts.

A safety net for **consumers** can be structured as a targeted facility (e.g., only low-income households are eligible for low-cost maize, or ideally, a financial transfer that compensates them for high maize prices[66]),

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[65] Eligible commodities under the CCC programme are feed grains, wheat, rice, peanuts, tobacco, upland cotton, extra-long staple cotton, sugar, soybeans, various oilseeds of the mustard family (crambe, canola, flaxseed, mustard seed, rapeseed), safflower and sunflower seed. Support prices are in principle rule-based (although the government has the discretionary power to change them): they can be no higher than 85% of average market prices for the preceding five years with the high and low years removed from the calculation, with adjustments determined on the basis of the stock levels in the country and with minimum and/or maximum support prices for certain crops. In 1996, the programme was restructured, and for most commodities farmers got an additional option: when the farmer deposits his goods, he gets a loan at the official loan rate (say 100 tons at US$ 200 a ton, so he receives a loan of US$ 20,000). Later on, he could still forfeit his crop, but he could also decide to repay the loan at the then-current price (say the price is US$ 150 a ton – he will then need to pay only US$ 15,000). This post-1996 mode of operations of the CCC loan programme is difficult to replicate for grains in East Africa as it is hard to get reliable reference prices.

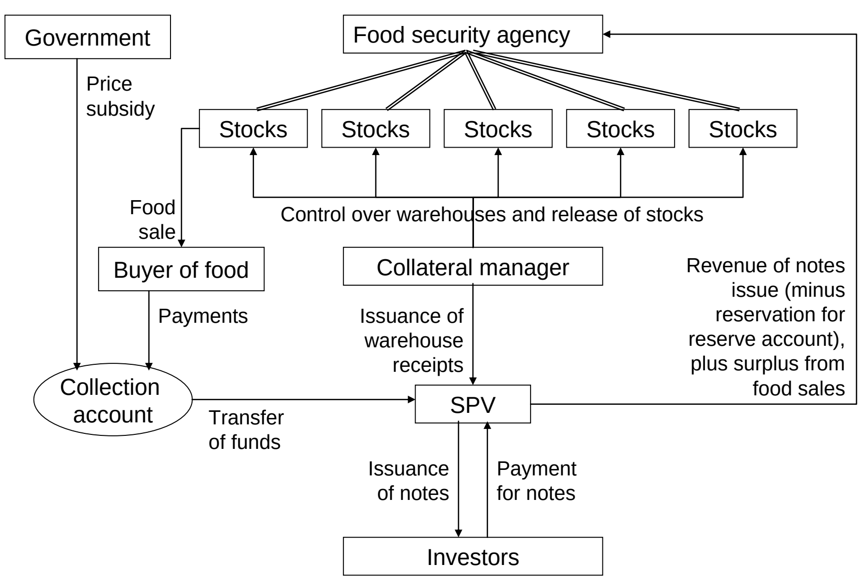
[66] Similar programmes for financial transfers operate, for example, in the USA, to support heating oil purchases by low-income households during the winter season. The municipalities that operate these programmes often hedge their price exposure on the commodity futures market, thus ensuring that their budget will be sufficient to meet the requirements.

or it can take the form of general price support. In either case, it can be much strengthened if the responsible government department or agency lays off the risks of “extreme events” through the use of weather index insurance (so that if there is a large production shortfall, the government immediately receives the funds needed for imports, without having to wait for donors), and by hedging maize import price risk in international markets (once a local maize contract emerges, this could also provide a hedging vehicle). The objective of the hedge would be to ensure that when imports are needed – which presumably will be the case when there is a shortfall in local or regional production – the import cost, expressed in local currency, will not be higher than a certain amount.

Use of market instruments for risk management requires that the responsible government department is professionally managed and free of political interference or managerial malfeasance in the management of its programmes. Moreover, there are many technical difficulties with designing an optimal hedge: What is the quantity to be hedged? What should be the timeframe? At what price should one hedge? Does one use an exchange contract – maize on SAFEX or CME – or should one negotiate a tailored product on the over-the-counter market? But in principle, it may be possible to design an option-based strategy that would be effective in underwriting a government’s maize safety net programme.

Furthermore, once basic market infrastructure (i.e., a commodity exchange and a reasonable warehousing infrastructure) has been created, Governments can much reduce the costs of strategic grain storage by having the private sector fund storage costs. Figure 41 gives an example of how this could work. In this example, the Food Reserve Agency can receive full value for its stocks (that is to say, the stocks are valued at market rates), as long as the government commits to pay into a collection account any subsidies that it may wish to provide (that is to say, for sales that the agency makes at prices below those prevailing in the market). A securitization like this can be designed in a flexible manner, allowing the issuance of short-term commercial paper for a value that corresponds to the food security agency's fluctuating stocks.

Figure 41
Securitizing the stocks of a food security agency



If the stocks are no longer there, the SPV has recourse to the collateral manager, which should guarantee its performance through its own balance sheet, and through policies with a reputable (and probably international) insurance company. For domestic securitization, such insurance will cover disaster risks as well as operational risks (e.g., the risks of the collateral manager's staff assisting in the theft of the commodities). For an international securitization, insurance would also cover various types of political risk (while there are also political risks for local securitizations arranged by local entities, it is impossible for a company to take out insurance against political risks related to the actions of its own government).

Reducing fork-to-farm costs

There is a way to achieve both higher prices for maize producers and lower prices for consumers and that is to make marketing chains more efficient, both over space and in time. Governments have a number of tools at their disposal:

(1) Improving road and other infrastructure, and removing costly domestic trade barriers (e.g., roadblocks).
(2) Improving the conditions for regional trade, including by reducing non-trade barriers such as overly cumbersome customs procedures.
(3) Improving market information so that the private sector can more easily arbitrage market inefficiencies (thus reducing them). A practical issue here is that market information systems have to be made self-supporting rather than dependent on continuous government or donor support. This goal is easiest to reach if there is a regional (spot or futures) commodity exchange - exchanges have a vested interest in spreading up-to-date price information as widely as possible, and will thus support the costs of price data gathering, analysis and distribution. It should be also noted that contrary to the prices disseminated by most market information systems, the prices of commodity exchanges are not only real-time, but also are prices at which one can effectively buy or sell.
(4) Support mechanisms that contribute to seasonal storage. This can be in the form of awareness-raising and training for bankers as well as potential clients; partial guarantees for warehouse receipt finance; support for the introduction of an electronic warehouse receipt system open to investors; and support for the development of commodity exchange mechanisms (a commodity exchange will enable urban speculators, for example, to invest in the storage of agricultural commodities, buying after harvest when they see prices are low and locking in an interest rate by selling the corresponding futures contracts).
(5) Eliminate discretionary policy interventions that discourage the private sector from investing in maize trade infrastructure. In Kenya, one component of this is to remove the overhang of NCPB warehouses from the market. One of the reasons that the private sector is now reticent to invest in new warehouses is the risk that NCPB will decide to open nearby warehouses at low storage costs. NCPB should sell or lease (for a long term) all the warehouses that it does not strictly need for its own operations.
(6) When governments intervene in markets (e.g., through the safety net approaches described above), they should do so in a way that strengthens market structures – for example, using the private sector (through a transparent, competitive process) as agent for procurement and distribution (eventually focusing on remote areas with poor marketing infrastructure), or targeting a food-for-work programme at the improvement of rural infrastructure.

Limiting price volatility through direct intervention

There are two main direct interventions through which governments can limit maize price volatility: a variable tariff regime, and buffer stocks.

Variable tariffs can be used to insulate local prices from international ones. Governments may be able to lay off much of the related revenue risk on international risk management markets. The difficulty with variable tariffs is that they create risks for private sector actors, and as a result act as a disincentive for otherwise-appropriate import and export transactions, and discourage investments in storage (both physical warehousing infrastructure and the storage of physical commodities). So a variable tariff regime should be designed to operate as predictably as possible, with floor and ceiling tariffs, and changes triggered by specific events. Tariffs should be set in such a way that inefficient production in the country is not encouraged.

The safety-net aspects of buffer stocks were discussed above. They are a tool for governments to buy when prices are low, and sell when they are high. In principle this reduces price volatility, but in practice buffer stocks face large governance issues so that their operations tend to discourage production and destabilize markets. And even if they work well, they can be expensive. In order to minimize costs, governments that wish to have the ability to boost sales in times of high prices may consider using "financial reserves" rather than physical ones. This can take the form of a fund (e.g., Senegal uses this model), or a set of risk management contracts.

While for normal trading purposes, the currently existing international maize futures contracts are of only very limited use, Governments could use them to leverage their food reserves. Grain futures contracts[67] constitute a "paper food reserve", and therefore can be used as an alternative for physical grain stocks, allowing national food reserve agencies to reduce their domestic stocks to the minimum quantities required to cover, in the case of a production shortfall, consumption needs until commercial imports or food aid can arrive in the country. The implied storage costs of the futures market (the "contango") are normally much lower than the real storage costs of the grain. The concomitant savings on storage have to be set off against firstly, the costs of holding the positions, and secondly, the risk that if the country requires large imports, transportation and port costs and bottlenecks increase. Nevertheless, savings for food reserve operations can be considerable.[68]

Dealing with potential conflicts between the policy elements

The sections above discussed a number of policies which each can help achieve government's objectives with respect to maize prices. These various mechanisms can infringe on each other if insufficient care is taken in design and implementation. The best way to ensure that various instruments can go together is for governments to step back from interventionist practices and commit to stable and predictable policies

[67] Or alternatively, financial reserves in combination with call options. This has been proposed, for example, for Southern Africa – the SADC Food Security Network, Ministerial Brief, 4 September 2001, argued that the typical annual storage charges for maize range between US$ 20 and US$ 40 a ton, compared to call option premiums of US$ 5 to US$ 10 per ton.

[68] FAO, 1995.

in any of the areas enumerated above. With such policies, markets and active governments are not mutually exclusive, and indeed, active governments can do much to make markets function better.

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Annex 1
Per capita cereal supply (kg/capita/year)

Cereals include: Wheat, Rice, Barley, Maize, Rye, Oats, Millet and Sorghum.

Per capita maize supply quantity (kg/capita/year)										
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Kenya	85.70	84.60	80.10	82.80	82.10	84.60	81.70	79.80	N.A.	N.A.
Tanzania	69.30	65.20	70.10	67.00	59.50	58.00	58.60	58.40	N.A.	N.A.
Uganda	29.10	29.20	29.50	29.20	27.60	26.10	24.90	24.20	N.A.	N.A.
Source: FAOSTAT Agriculture										

Maize production (000 tons)										
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Kenya	2160	2790	2409	2711	2607	2906	3247	2929	2367	2439
Tanzania	1965	2653	4408	2614	4651	3132	3423	3659	3556	3324
Uganda	1096	1174	1217	1300	1080	1170	1258	1262	1266	1272
Source: FAOSTAT Agriculture										

KENYA

	Total cereals supply (kg per capita)	**Of which: wheat (%)**	**Of which: maize (%)**
2000	119.1	22%	72%
2001	120	23%	70%
2002	113.8	22%	70%
2003	117.6	21%	70%
2004	113.7	19%	72%
2005	122	22%	69%
2006	119.5	22%	68%
2007	119.5	22%	67%
Source: FAOSTAT Agriculture			

TANZANIA

	Total cereals supply (kg per capita)	Of which: wheat (%)	Of which: maize (%)
2000	105.8	7%	65%
2001	106.5	11%	61%
2002	108.5	12%	65%
2003	103	10%	65%
2004	101.8	12%	58%
2005	102.2	14%	57%
2006	103.6	14%	57%
2007	105.7	15%	55%
Source: FAOSTAT Agriculture			

UGANDA

	Total cereals supply (kg per capita)	Of which: wheat (%)	Of which: maize (%)
2000	60.2	8%	48%
2001	55.9	4%	52%
2002	59.9	9%	49%
2003	62	11%	47%
2004	63	15%	44%
2005	65.6	19%	40%
2006	63.7	20%	39%
2007	61.3	17%	39%
Source: FAOSTAT Agriculture			

Annex 2
Analysis of the relative importance of price risk in overall revenue exposure: the case of Kenya

Risk is estimated by the standard deviation or the coefficient of variation (which is the standard deviation divided by the mean of the series). In a macro sense, we measure volatility in production, prices and revenues (which can be considered as a proxy for incomes of the producers) by coefficient of variation or standard deviation of these variables. In a time-series, the coefficient of variation may be a better indicator than the standard deviation, as the mean of the variable is expected to change. If the fluctuations in production and prices are negatively correlated, then the fluctuations in farmers' income/revenue will be lower.

The analysis in this annex looks at the case of Kenya, for which have data on prices and production are available from 1979 to 2010 (32 observations). Summary statistics have been evaluated which includes standard deviations and coefficient of variation for the whole period, as well as three sub-periods:

- 10 observations: 1980-1989
- 10 observations: 1990-1999
- 11 observations: 2000-2010

The analysis is based on the data of table 2.9. The main findings are as follows.

Table 2.1
Extent of volatility, 1979 - 2010

Variable	Obs	Mean	Std. Dev.	Min	Max	CV
Area	32	1483263	216848.8	985000	2008346	14.62
q_mt	32	2450518	431409.8	1422000	3247200	17.60
p_bag	32	852	621	89	2549	72.88
r_kmn	32	24317	18726	1742	69084	77.01

It can be observed that over this full period, fluctuations in prices are more than four times that of quantities and hence, the prime cause of volatility in incomes received by the farmers.

Table 2.2
Covariances and correlations between production, prices and revenue, 1979 - 2010

Covariance	q_mt	p_bag	r_kmn
q_mt	190000000000		
p_bag	100000000	385541	
r_kmn	4300000000	11000000	350000000

Correlation	q_mt	p_bag	r_kmn
q_mt	1.0000		
p_bag	0.3879	1.0000	
r_kmn	0.5381	0.9755	1.0000

The correlations and covariances of prices and quantities are positive, which indicates that fluctuations caused in incomes have aggravated rather than neutralized by movements in prices and quantities. The correlation of revenue with price is much higher than the correlation of revenue with quantity.

Repeating this same analysis for the three separate time periods gives results as below.

1980-1989:

Table 2.3
Extent of volatility, 1980 - 1989

Variable	Obs	Mean	Std. Dev.	Min	Max	CV
Area	10	1307650	155803.4	985000	1450939	11.91
q_mt	10	2274750	501184.3	1422000	2898000	22.03
p_bag	10	240	51	171	306	21.43
r_kmn	10	6126	2151	3542	9388	35.12

During the 1980s, fluctuations in prices are quite comparable to those of quantities and hence, both p and q have been equally important reasons for the volatility in incomes received by the farmers. And as the table below shows, the correlation of revenue with price is comparable to the correlation of revenue with quantity.

Table 2.4
Covariances and correlations between production, prices and revenue, 1980 - 1989

	q_mt	p_bag	r_kmn
q_mt	250000000000		
p_bag	6200000	2643	
r_kmn	870000000	84106	4600000

	q_mt	p_bag	r_kmn
q_mt	1.0000		
p_bag	0.2399	1.0000	
r_kmn	0.8049	0.7605	1.0000

1990-1999:

Table 2.5
Extent of volatility, 1990 - 1999

Variable	Obs	Mean	Std. Dev.	Min	Max	CV
Area	10	1441604	80655	1310000	1567240	5.59
q_mt	10	2412770	285864	2089000	3060000	11.85
p_bag	10	861	365	311	1399	42.36
r_kmn	10	23176	10363	7916	38137	44.72

Over the 1990s, fluctuations in prices are almost four times that of quantities and hence, the prime cause of volatility in incomes received by the farmers.

Table 2.6
Covariances and correlations between production, prices and revenue, 1990 - 1999

	q_mt	p_bag	r_kmn
q_mt	82000000000		
p_bag	9100000	133077	
r_kmn	1200000000	3600000	110000000

	q_mt	p_bag	r_kmn
q_mt	1.0000		
p_bag	0.0876	1.0000	
r_kmn	0.3917	0.9490	1.0000

The correlations and covariances of prices and quantities are positive but rather low. The prime reason for fluctuations in income seems to lie in the movements in prices. The correlation of revenue with price is much higher than the correlation of revenue with quantity.

2000-2010:

Table 2.7
Extent of volatility, 2000 - 2010

Variable	Obs	Mean	Std. Dev.	Min	Max	CV
Area	11	1692898	188089	1351327	2008346	11.11
q_mt	11	2707852	351859	2160000	3247200	12.99
p_bag	11	1470	470	800	2549	31.96
r_kmn	11	43944	13390	21404	69084	30.47

During the 2000s, fluctuations in prices are predominant as compared to fluctuations in quantities, though to a much lesser extent than in the preceding decade. Also, unlike the preceding periods, there is a negative correlation between prices and quantities, indicating income stabilization operating through this negative correlation for farmers. However, it has adverse implication for consumers, as they will suffer on account of falling quantities of maize and higher prices.

Table 2.8
Covariances and correlations between production, prices and revenue, 2000 - 2010

	q_mt	p_bag	r_kmn
q_mt	120000000000		
p_bag	-27000000	220649	
r_kmn	1300000000	5700000	180000000

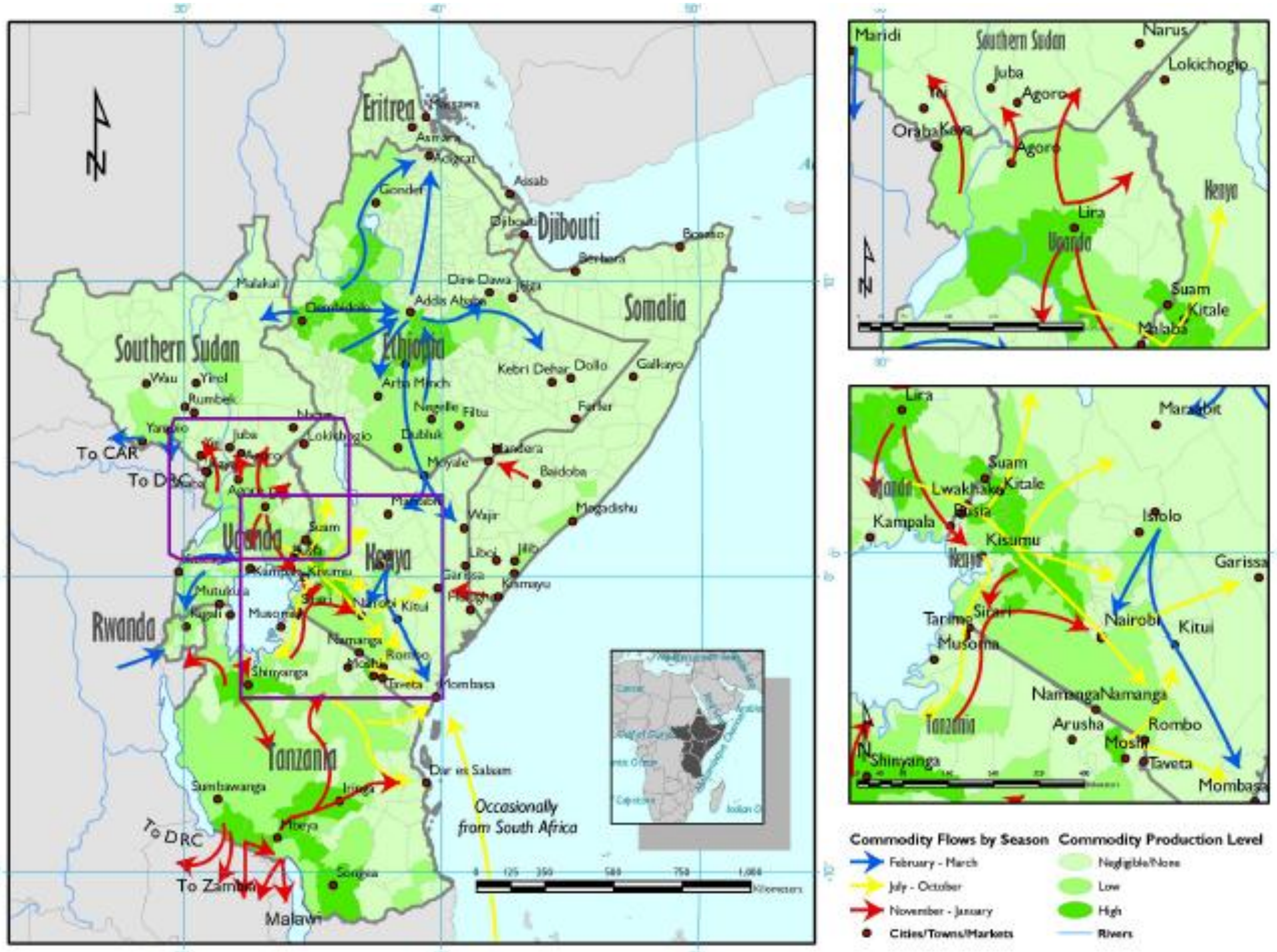
	q_mt	p_bag	r_kmn
q_mt	1.0000		
p_bag	-0.1620	1.0000	
r_kmn	0.2724	0.9029	1.0000

Table 2.9

Area under maize production, production, price per bag and revenue in Kenya, 1980 - 2010

Year	Area	Q_MT	P_bag	R_kmn
1980	1350000	1620000	217.1	3907
1981	1120000	1768000	180.3	3542
1982	1208000	2502000	171.1	4758
1983	1300000	2300000	173.9	4443
1984	985000	1422000	285.3	4507
1985	1411000	2430000	279.5	7545
1986	1424600	2898000	257.6	8295
1987	1406956	2415600	240.4	6452
1988	1450939	2761200	306.0	9388
1989	1420000	2630700	288.0	8419
1990	1380000	2289600	311.2	7916
1991	1310000	2400000	332.9	8879
1992	1407000	2430000	711.9	19221
1993	1343500	2089000	837.2	19432
1994	1500000	3060000	1121.7	38137
1995	1438740	2698863	697.4	20915
1996	1489000	2160000	836.6	20078
1997	1504820	2214000	1398.9	34413
1998	1475740	2464101	1139.8	31205
1999	1567240	2322140	1223.4	31567
2000	1500000	2160000	1380.5	33131
2001	1640000	2790000	1091.2	33826
2002	1592315	2408596	799.8	21404
2003	1670914	2710848	1278.3	38504
2004	1351327	2607139	1524.4	44160
2005	1771123	2905559	1338.0	43196
2006	1888185	3247200	1390.9	50185
2007	1615304	2928793	1166.7	37968
2008	1700000	2367237	1958.2	51505
2009	1884368	2439000	2549.2	69084
2010	2008346	3222000	1687.8	60422

Annex 3
Maize Production and Market Flows in East Africa



Source: http://www.fews.net

Annex 4 Empirical Results Nairobi Market

Null Hypothesis: LN_NAIROBI has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.706761	0.7371
Test critical values:	1% level	-4.105534	
	5% level	-3.480463	
	10% level	-3.168039	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.009895
HAC corrected variance (Bartlett kernel)	0.013478

Phillips-Perron Test Equation
Dependent Variable: D(LN_NAIROBI)
Method: Least Squares
Date: 06/30/11 Time: 13:48
Sample (adjusted): 2006M02 2011M06
Included observations: 65 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_NAIROBI(-1)	-0.073379	0.053119	-1.381405	0.1721
C	0.392159	0.287668	1.363236	0.1777
@TREND(2006M01)	0.000882	0.000738	1.195063	0.2366

R-squared	0.037056	Mean dependent var	0.011701
Adjusted R-squared	0.005993	S.D. dependent var	0.102159
S.E. of regression	0.101852	Akaike info criterion	-1.685533
Sum squared resid	0.643180	Schwarz criterion	-1.585176
Log likelihood	57.77981	F-statistic	1.192931
Durbin-Watson stat	1.764566	Prob(F-statistic)	0.310196

Null Hypothesis: D(LN_NAIROBI) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.317537	0.0000
Test critical values:	1% level	-4.107947	
	5% level	-3.481595	
	10% level	-3.168695	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.010233
HAC corrected variance (Bartlett kernel)	0.011830

Phillips-Perron Test Equation
Dependent Variable: D(LN_NAIROBI,2)
Method: Least Squares
Date: 06/30/11 Time: 13:49
Sample (adjusted): 2006M03 2011M06
Included observations: 64 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_NAIROBI(-1))	-0.934555	0.129112	-7.238337	0.0000
C	-0.008308	0.026822	-0.309759	0.7578
@TREND(2006M01)	0.000553	0.000702	0.787741	0.4339

R-squared	0.462938	Mean dependent var	0.001446
Adjusted R-squared	0.445330	S.D. dependent var	0.139126
S.E. of regression	0.103616	Akaike info criterion	-1.650513
Sum squared resid	0.654910	Schwarz criterion	-1.549315
Log likelihood	55.81642	F-statistic	26.29050
Durbin-Watson stat	2.003294	Prob(F-statistic)	0.000000

Correlogram of D_ln_Nairobi

Date: 06/30/11 Time: 12:39
Sample: 2006M01 2011M06
Included observations: 65

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.034	0.034	0.0787	0.779
. |*. |	. |*. |	2	0.117	0.116	1.0329	0.597
. | . |	. | . |	3	0.005	-0.002	1.0347	0.793
. | . |	. | . |	4	-0.004	-0.018	1.0361	0.904
. | . |	. | . |	5	0.057	0.058	1.2703	0.938
. |*. |	. |*. |	6	0.105	0.106	2.0780	0.912
. | . |	. | . |	7	-0.031	-0.052	2.1493	0.951
.*| . |	.*| . |	8	-0.158	-0.186	4.0478	0.853
. |*. |	. |*. |	9	0.144	0.177	5.6565	0.774
. | . |	. | . |	10	-0.028	0.007	5.7172	0.838
. |*. |	. | . |	11	0.084	0.026	6.2806	0.854
. | . |	.*| . |	12	-0.044	-0.067	6.4373	0.892
. | . |	. | . |	13	0.013	0.047	6.4524	0.928
.*| . |	.*| . |	14	-0.086	-0.060	7.0790	0.932
. | . |	.*| . |	15	-0.025	-0.082	7.1344	0.954
. | . |	. | . |	16	0.012	0.017	7.1483	0.970
.*| . |	. | . |	17	-0.067	-0.006	7.5555	0.975
. | . |	. | . |	18	-0.010	-0.033	7.5643	0.984
.*| . |	. | . |	19	-0.068	-0.045	7.9981	0.987
.*| . |	.*| . |	20	-0.099	-0.106	8.9406	0.984
. | . |	. | . |	21	-0.003	0.054	8.9417	0.990
. |*. |	. |*. |	22	0.085	0.076	9.6652	0.989
. | . |	. | . |	23	-0.023	-0.019	9.7203	0.993
. | . |	. | . |	24	-0.021	-0.039	9.7688	0.995
. | . |	. |*. |	25	0.033	0.069	9.8891	0.997
. | . |	. | . |	26	-0.019	0.018	9.9282	0.998
. | . |	. | . |	27	0.049	-0.013	10.203	0.999
. | . |	. | . |	28	0.038	0.003	10.376	0.999

Annex 5 Empirical Results for Mombasa Market

Null Hypothesis: LN_MOMBASA has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.795650	0.6955
Test critical values:	1% level	-4.105534	
	5% level	-3.480463	
	10% level	-3.168039	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.008432
HAC corrected variance (Bartlett kernel)	0.015149

Phillips-Perron Test Equation
Dependent Variable: D(LN_MOMBASA)
Method: Least Squares
Date: 06/30/11 Time: 13:51
Sample (adjusted): 2006M02 2011M06
Included observations: 65 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_MOMBASA(-1)	-0.057277	0.047448	-1.207133	0.2320
C	0.298682	0.255334	1.169771	0.2466
@TREND(2006M01)	0.000875	0.000675	1.296115	0.1997

R-squared	0.035192	Mean dependent var	0.010175
Adjusted R-squared	0.004069	S.D. dependent var	0.094215
S.E. of regression	0.094023	Akaike info criterion	-1.845503
Sum squared resid	0.548099	Schwarz criterion	-1.745146
Log likelihood	62.97884	F-statistic	1.130740
Durbin-Watson stat	1.385174	Prob(F-statistic)	0.329359

Null Hypothesis: D(LN_MOMBASA) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.917171	0.0000
Test critical values:	1% level	-4.107947	
	5% level	-3.481595	
	10% level	-3.168695	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.008044
HAC corrected variance (Bartlett kernel)	0.008660

Phillips-Perron Test Equation
Dependent Variable: D(LN_MOMBASA,2)
Method: Least Squares
Date: 06/30/11 Time: 13:51
Sample (adjusted): 2006M03 2011M06
Included observations: 64 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_MOMBASA(-1))	-0.717091	0.122660	-5.846191	0.0000
C	-0.007947	0.023807	-0.333829	0.7397
@TREND(2006M01)	0.000450	0.000625	0.718695	0.4751

R-squared	0.359134	Mean dependent var	-1.19E-05
Adjusted R-squared	0.338122	S.D. dependent var	0.112923
S.E. of regression	0.091870	Akaike info criterion	-1.891146
Sum squared resid	0.514845	Schwarz criterion	-1.789949
Log likelihood	63.51668	F-statistic	17.09186
Durbin-Watson stat	2.043140	Prob(F-statistic)	0.000001

Date: 06/30/11 Time: 13:51
Sample: 2006M01 2011M06
Included observations: 65

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |** |	. |** |	1	0.288	0.288	5.6374	0.018
. |*. |	. |*. |	2	0.150	0.073	7.1896	0.027
. |*. |	. | . |	3	0.070	0.010	7.5348	0.057
.*| . |	.*| . |	4	-0.076	-0.118	7.9447	0.094
. | . |	. |*. |	5	0.050	0.102	8.1234	0.150
. | . |	. | . |	6	-0.004	-0.025	8.1246	0.229
. | . |	. | . |	7	0.000	0.002	8.1246	0.322
. | . |	. | . |	8	0.026	0.010	8.1765	0.416
. | . |	. | . |	9	0.009	0.018	8.1822	0.516
. | . |	. | . |	10	-0.023	-0.046	8.2235	0.607
. |*. |	. |*. |	11	0.088	0.116	8.8428	0.636
. | . |	.*| . |	12	-0.022	-0.076	8.8843	0.713
. | . |	. | . |	13	0.024	0.038	8.9335	0.778
.*| . |	.*| . |	14	-0.066	-0.107	9.3019	0.811
.*| . |	. | . |	15	-0.104	-0.031	10.239	0.804
.*| . |	.*| . |	16	-0.079	-0.065	10.796	0.822
. | . |	. |*. |	17	0.034	0.134	10.903	0.862
. | . |	. | . |	18	0.044	-0.010	11.084	0.891
.*| . |	.*| . |	19	-0.081	-0.121	11.698	0.898
.*| . |	.*| . |	20	-0.116	-0.109	13.011	0.877
.*| . |	. | . |	21	-0.131	-0.016	14.718	0.837
. | . |	. | . |	22	-0.005	0.062	14.720	0.874
. | . |	. | . |	23	0.038	0.060	14.872	0.899
. |*. |	. | . |	24	0.086	0.045	15.664	0.900
. | . |	. | . |	25	0.030	-0.027	15.764	0.922
. | . |	. | . |	26	-0.008	-0.029	15.772	0.942
. | . |	. | . |	27	0.001	0.035	15.772	0.957
. | . |	. | . |	28	0.022	0.029	15.831	0.968

AR(1) Model for conditional mean

Dependent Variable: D_LN_MOMBASA
Method: Least Squares
Date: 06/30/11 Time: 13:54
Sample (adjusted): 2006M03 2011M05
Included observations: 63 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.010741	0.016684	0.643758	0.5221
AR(1)	0.303669	0.125610	2.417552	0.0186

R-squared	0.087435	Mean dependent var	0.009671
Adjusted R-squared	0.072475	S.D. dependent var	0.095678
S.E. of regression	0.092146	Akaike info criterion	-1.899652
Sum squared resid	0.517945	Schwarz criterion	-1.831616
Log likelihood	61.83905	Durbin-Watson stat	2.029337

Inverted AR Roots	.30

Correlogram of the residuals

Date: 06/30/11 Time: 13:56
Sample: 2006M03 2011M05
Included observations: 63
Q-statistic probabilities adjusted for 1 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	-0.028	-0.028	0.0525	
. |*. |	. |*. |	2	0.073	0.072	0.4059	0.524
. |*. |	. |*. |	3	0.080	0.085	0.8443	0.656
.*| . |	.*| . |	4	-0.086	-0.087	1.3563	0.716
. |*. |	. | . |	5	0.068	0.052	1.6819	0.794
. | . |	. | . |	6	-0.011	-0.002	1.6913	0.890
. | . |	. | . |	7	-0.003	0.001	1.6920	0.946
. | . |	. | . |	8	0.013	-0.003	1.7036	0.974
. | . |	. | . |	9	0.018	0.031	1.7287	0.988
.*| . |	.*| . |	10	-0.059	-0.065	1.9985	0.991
. |*. |	. |*. |	11	0.122	0.119	3.1612	0.977
.*| . |	. | . |	12	-0.064	-0.056	3.4896	0.983
. | . |	. | . |	13	0.055	0.051	3.7333	0.988
. | . |	.*| . |	14	-0.042	-0.068	3.8775	0.992
.*| . |	. | . |	15	-0.083	-0.054	4.4604	0.992
.*| . |	.*| . |	16	-0.079	-0.115	5.0016	0.992
. | . |	. |*. |	17	0.053	0.098	5.2526	0.994
. |*. |	. |*. |	18	0.072	0.080	5.7303	0.995
.*| . |	.*| . |	19	-0.074	-0.069	6.2383	0.995
.*| . |	.*| . |	20	-0.061	-0.115	6.5878	0.996
.*| . |	.*| . |	21	-0.121	-0.091	8.0067	0.992
. | . |	. | . |	22	0.022	0.026	8.0569	0.995
. | . |	. | . |	23	0.018	0.064	8.0916	0.997
. |*. |	. |*. |	24	0.084	0.088	8.8272	0.997
. | . |	. | . |	25	0.005	-0.004	8.8295	0.998
. | . |	. | . |	26	-0.024	-0.047	8.8949	0.999
. | . |	. | . |	27	-0.005	-0.002	8.8974	0.999
. | . |	. | . |	28	0.039	0.057	9.0743	1.000

Annex 6 Empirical Results Nakuru Market

Null Hypothesis: LN_NAKURU has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.122769	0.5182
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.010035
HAC corrected variance (Bartlett kernel)	0.025657

Phillips-Perron Test Equation
Dependent Variable: D(LN_NAKURU)
Method: Least Squares
Date: 06/30/11 Time: 14:05
Sample (adjusted): 2008M02 2011M06
Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_NAKURU(-1)	-0.093047	0.060023	-1.550182	0.1294
C	0.567404	0.349070	1.625475	0.1123
@TREND(2008M01)	-0.001109	0.001456	-0.761920	0.4508

R-squared	0.061088	Mean dependent var	0.021127
Adjusted R-squared	0.011672	S.D. dependent var	0.104668
S.E. of regression	0.104056	Akaike info criterion	-1.617424
Sum squared resid	0.411449	Schwarz criterion	-1.492040
Log likelihood	36.15718	F-statistic	1.236194
Durbin-Watson stat	0.957415	Prob(F-statistic)	0.301905

Null Hypothesis: D(LN_NAKURU) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.451523	0.0588
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.008104
HAC corrected variance (Bartlett kernel)	0.008357

Phillips-Perron Test Equation
Dependent Variable: D(LN_NAKURU,2)
Method: Least Squares
Date: 06/30/11 Time: 14:05
Sample (adjusted): 2008M03 2011M06
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_NAKURU(-1))	-0.491864	0.143880	-3.418576	0.0015
C	0.004085	0.031703	0.128844	0.8982
@TREND(2008M01)	0.000277	0.001287	0.215511	0.8306

R-squared	0.244283	Mean dependent var	0.000967
Adjusted R-squared	0.203433	S.D. dependent var	0.104872
S.E. of regression	0.093599	Akaike info criterion	-1.827561
Sum squared resid	0.324147	Schwarz criterion	-1.700895
Log likelihood	39.55121	F-statistic	5.980049
Durbin-Watson stat	2.290292	Prob(F-statistic)	0.005619

Date: 06/30/11 Time: 14:06
Sample: 2008M01 2011M06
Included observations: 41

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*** |	. |*** |	1	0.447	0.447	8.8251	0.003
. |*** |	. |** |	2	0.360	0.200	14.681	0.001
. |** |	. | . |	3	0.237	0.024	17.288	0.001
. | . |	**| . |	4	0.015	-0.193	17.299	0.002
. |*. |	. |*. |	5	0.101	0.128	17.795	0.003
. |*. |	. |*. |	6	0.096	0.093	18.258	0.006
.*| . |	**| . |	7	-0.071	-0.201	18.517	0.010
. | . |	. |*. |	8	0.045	0.068	18.624	0.017
. |*. |	. |*. |	9	0.069	0.154	18.888	0.026
. |*. |	. |*. |	10	0.110	0.095	19.570	0.034
. | . |	**| . |	11	0.029	-0.239	19.620	0.051
. |*. |	. |*. |	12	0.067	0.096	19.890	0.069
. | . |	. | . |	13	-0.031	0.016	19.952	0.096
. | . |	. | . |	14	0.025	0.019	19.992	0.130
. | . |	. | . |	15	0.040	-0.055	20.102	0.168
.*| . |	.*| . |	16	-0.076	-0.086	20.510	0.198
.*| . |	. | . |	17	-0.094	-0.018	21.154	0.219
.*| . |	. | . |	18	-0.065	0.001	21.479	0.256
. | . |	. |*. |	19	-0.049	0.071	21.673	0.301
. | . |	.*| . |	20	-0.005	-0.066	21.675	0.358

Dependent Variable: D_LN_NAKURU
Method: Least Squares
Date: 06/30/11 Time: 14:09
Sample (adjusted): 2008M03 2011M05
Included observations: 39 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.019643	0.029964	0.655548	0.5162
AR(1)	0.498749	0.149819	3.329009	0.0020

R-squared	0.230486	Mean dependent var	0.016658
Adjusted R-squared	0.209688	S.D. dependent var	0.105319
S.E. of regression	0.093628	Akaike info criterion	**-1.849048**
Sum squared resid	0.324351	Schwarz criterion	**-1.763737**
Log likelihood	38.05644	Durbin-Watson stat	2.235130

Inverted AR Roots .50

Dependent Variable: D_LN_NAKURU
Method: Least Squares
Date: 06/30/11 Time: 14:10
Sample (adjusted): 2008M04 2011M05
Included observations: 38 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.018770	0.042513	0.441502	0.6616
AR(1)	0.357350	0.164068	2.178057	0.0362
AR(2)	0.292158	0.168100	1.737999	0.0910

R-squared	0.282028	Mean dependent var	0.013565
Adjusted R-squared	0.241001	S.D. dependent var	0.104922
S.E. of regression	0.091409	Akaike info criterion	-1.871288
Sum squared resid	0.292446	Schwarz criterion	-1.742005
Log likelihood	38.55447	Durbin-Watson stat	2.053593

Inverted AR Roots .75 -.39

Dependent Variable: D_LN_NAKURU
Method: Least Squares
Date: 06/30/11 Time: 14:12
Sample (adjusted): 2008M03 2011M05
Included observations: 39 after adjustments
Convergence achieved after 15 iterations
Backcast: 2008M02

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.015245	0.045954	0.331753	0.7420
AR(1)	0.829184	0.156903	5.284695	0.0000
MA(1)	-0.472891	0.234995	-2.012340	0.0517

R-squared	0.307195	Mean dependent var	0.016658
Adjusted R-squared	0.268705	S.D. dependent var	0.105319
S.E. of regression	0.090065	Akaike info criterion	-1.902776
Sum squared resid	0.292019	Schwarz criterion	-1.774810
Log likelihood	40.10413	Durbin-Watson stat	2.032344

Inverted AR Roots	.83
Inverted MA Roots	.47

Correlogram for the ARMA (1,1) model

Date: 06/30/11 Time: 14:15
Sample: 2008M03 2011M05
Included observations: 39
Q-statistic probabilities adjusted for 2 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	-0.038	-0.038	0.0599	
. |*. |	. |*. |	2	0.087	0.086	0.3866	
. |*. |	. |*. |	3	0.119	0.126	1.0156	0.314
. *| . |	. *| . |	4	-0.159	-0.160	2.1675	0.338
. | . |	. | . |	5	0.044	0.012	2.2595	0.520
. |*. |	. |*. |	6	0.100	0.124	2.7475	0.601
.**| . |	.**| . |	7	-0.230	-0.206	5.3833	0.371
. | . |	. | . |	8	0.025	-0.041	5.4167	0.492
. | . |	. |*. |	9	0.053	0.102	5.5669	0.591
. |*. |	. |** |	10	0.104	0.202	6.1613	0.629
. | . |	. *| . |	11	0.008	-0.099	6.1653	0.723
. |*. |	. | . |	12	0.069	0.020	6.4481	0.776
. *| . |	. | . |	13	-0.103	-0.045	7.1031	0.791
. | . |	. | . |	14	0.011	-0.003	7.1114	0.850
. |*. |	. |*. |	15	0.098	0.067	7.7467	0.860
. | . |	. | . |	16	-0.057	-0.022	7.9755	0.891

Annex 7 Empirical Results for Dar Es Salaam Market

Null Hypothesis: LN_DAR_ES_SALAAM has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.197881	0.4826
Test critical values:	1% level	-4.105534	
	5% level	-3.480463	
	10% level	-3.168039	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.011646
HAC corrected variance (Bartlett kernel)	0.022269

Phillips-Perron Test Equation
Dependent Variable: D(LN_DAR_ES_SALAAM)
Method: Least Squares
Date: 06/30/11 Time: 17:54
Sample (adjusted): 2 66
Included observations: 65 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_DAR_ES_SALAAM(-1)	-0.078294	0.045378	-1.725385	0.0894
C	0.389913	0.235420	1.656243	0.1027
@TREND(1)	0.001207	0.000835	1.446032	0.1532

R-squared	0.052913	Mean dependent var	0.003371
Adjusted R-squared	0.022362	S.D. dependent var	0.111751
S.E. of regression	0.110494	Akaike info criterion	-1.522650
Sum squared resid	0.756958	Schwarz criterion	-1.422293
Log likelihood	52.48612	F-statistic	1.731935
Durbin-Watson stat	1.387890	Prob(F-statistic)	0.185392

Null Hypothesis: D(LN_DAR_ES_SALAAM) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.771287	0.0001
Test critical values:	1% level	-4.107947	
	5% level	-3.481595	
	10% level	-3.168695	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.011384
HAC corrected variance (Bartlett kernel)	0.010886

Phillips-Perron Test Equation
Dependent Variable: D(LN_DAR_ES_SALAAM,2)
Method: Least Squares
Date: 06/30/11 Time: 17:54
Sample (adjusted): 3 66
Included observations: 64 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_DAR_ES_SALAAM(-1))	-0.723875	0.124511	-5.813747	0.0000
C	-0.013133	0.028389	-0.462632	0.6453
@TREND(1)	0.000421	0.000745	0.564557	0.5744

R-squared	0.356678	Mean dependent var	-0.002958
Adjusted R-squared	0.335586	S.D. dependent var	0.134074
S.E. of regression	0.109286	Akaike info criterion	-1.543961
Sum squared resid	0.728545	Schwarz criterion	-1.442764
Log likelihood	52.40676	F-statistic	16.91018
Durbin-Watson stat	2.026157	Prob(F-statistic)	0.000001

Date: 06/30/11 Time: 18:01
Sample: 1 66
Included observations: 65

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |** |	. |** |	1	0.310	0.310	6.5396	0.011
. |** |	. |** |	2	0.285	0.209	12.141	0.002
. | . |	.*| . |	3	0.043	-0.106	12.272	0.007
. |** |	. |*. |	4	0.210	0.192	15.419	0.004
.*| . |	***| . |	5	-0.188	-0.330	17.986	0.003
.*| . |	.*| . |	6	-0.158	-0.131	19.821	0.003
.*| . |	. |*. |	7	-0.145	0.093	21.397	0.003
. | . |	. | . |	8	-0.019	-0.005	21.425	0.006
.*| . |	. | . |	9	-0.073	0.063	21.836	0.009
.*| . |	.*| . |	10	-0.123	-0.150	23.042	0.011
. | . |	. |*. |	11	0.035	0.082	23.140	0.017
.*| . |	.*| . |	12	-0.071	-0.146	23.552	0.023
. | . |	. | . |	13	-0.010	0.012	23.559	0.035
**| . |	.*| . |	14	-0.196	-0.120	26.853	0.020
. | . |	. | . |	15	0.014	0.023	26.870	0.030
.*| . |	.*| . |	16	-0.170	-0.094	29.451	0.021
.*| . |	.*| . |	17	-0.097	-0.123	30.312	0.024
.*| . |	. | . |	18	-0.153	0.059	32.480	0.019
. |*. |	. |*. |	19	0.102	0.078	33.459	0.021
. | . |	. | . |	20	0.036	0.052	33.583	0.029
. | . |	.*| . |	21	0.035	-0.080	33.704	0.039
. | . |	.*| . |	22	0.002	-0.074	33.705	0.053
. | . |	.*| . |	23	0.046	-0.063	33.923	0.066
. | . |	. | . |	24	0.009	-0.021	33.931	0.086
. | . |	. |*. |	25	-0.025	0.108	33.998	0.108
. | . |	.*| . |	26	-0.039	-0.103	34.169	0.131
. | . |	. | . |	27	-0.011	0.034	34.184	0.161
. | . |	.*| . |	28	-0.015	-0.105	34.213	0.194

Dependent Variable: D_LN_DAR_ES_SALAAM
Method: Least Squares
Date: 06/30/11 Time: 18:00
Sample (adjusted): 3 65
Included observations: 63 after adjustments
Convergence achieved after 9 iterations
Backcast: 1 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.006051	0.019272	0.313986	0.7546
AR(1)	-0.789974	0.136249	-5.798032	0.0000
MA(1)	1.188750	0.144380	8.233481	0.0000
MA(2)	0.538552	0.098459	5.469788	0.0000

R-squared	0.239022	Mean dependent var	0.004506
Adjusted R-squared	0.200328	S.D. dependent var	0.112069
S.E. of regression	0.100217	Akaike info criterion	-1.701572
Sum squared resid	0.592563	Schwarz criterion	-1.565500
Log likelihood	57.59952	Durbin-Watson stat	1.926905

Inverted AR Roots	-.79	
Inverted MA Roots	-.59-.43i	-.59+.43i

Annex 8 **Empirical Results for Kampala Market**

Null Hypothesis: LN_KAMPALA has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.912990	0.6364
Test critical values:	1% level	-4.105534	
	5% level	-3.480463	
	10% level	-3.168039	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.023056
HAC corrected variance (Bartlett kernel)	0.028040

Phillips-Perron Test Equation
Dependent Variable: D(LN_KAMPALA)
Method: Least Squares
Date: 06/30/11 Time: 18:19
Sample (adjusted): 2 66
Included observations: 65 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_KAMPALA(-1)	-0.094478	0.054414	-1.736297	0.0875
C	0.483324	0.284603	1.698237	0.0945
@TREND(1)	0.000740	0.001050	0.704963	0.4835

R-squared	0.048218	Mean dependent var	0.005885
Adjusted R-squared	0.017515	S.D. dependent var	0.156853
S.E. of regression	0.155473	Akaike info criterion	-0.839632
Sum squared resid	1.498658	Schwarz criterion	-0.739276
Log likelihood	30.28805	F-statistic	1.570482
Durbin-Watson stat	1.567467	Prob(F-statistic)	0.216104

Null Hypothesis: D(LN_KAMPALA) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.462848	0.0000
Test critical values:	1% level	-4.107947	
	5% level	-3.481595	
	10% level	-3.168695	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.023762
HAC corrected variance (Bartlett kernel)	0.021849

Phillips-Perron Test Equation
Dependent Variable: D(LN_KAMPALA,2)
Method: Least Squares
Date: 06/30/11 Time: 18:20
Sample (adjusted): 3 66
Included observations: 64 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_KAMPALA(-1))	-0.820516	0.125961	-6.514047	0.0000
C	-0.005630	0.040883	-0.137707	0.8909
@TREND(1)	0.000312	0.001070	0.292007	0.7713

R-squared	0.410245	Mean dependent var	-2.57E-05
Adjusted R-squared	0.390909	S.D. dependent var	0.202315
S.E. of regression	0.157895	Akaike info criterion	-0.808032
Sum squared resid	1.520781	Schwarz criterion	-0.706834
Log likelihood	28.85702	F-statistic	21.21642
Durbin-Watson stat	1.993444	Prob(F-statistic)	0.000000

Date: 06/30/11 Time: 18:26
Sample: 1 66
Included observations: 65

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*. |	. |*. |	1	0.181	0.181	2.2332	0.135
. | . |	. | . |	2	0.043	0.010	2.3581	0.308
**| . |	**| . |	3	-0.196	-0.213	5.0661	0.167
.*| . |	. | . |	4	-0.084	-0.013	5.5691	0.234
. |*. |	. |** |	5	0.148	0.199	7.1489	0.210
. |*. |	. |*. |	6	0.182	0.097	9.6047	0.142
. | . |	.*| . |	7	0.035	-0.070	9.6982	0.206
.*| . |	.*| . |	8	-0.147	-0.119	11.354	0.182
**| . |	.*| . |	9	-0.200	-0.087	14.462	0.107
. | . |	. | . |	10	-0.031	0.037	14.539	0.150
. | . |	. | . |	11	0.020	-0.051	14.572	0.203
. |*. |	. | . |	12	0.120	0.041	15.758	0.203
. |*. |	. |*. |	13	0.066	0.079	16.123	0.243
. | . |	. | . |	14	-0.017	0.027	16.147	0.304
.*| . |	.*| . |	15	-0.100	-0.070	17.015	0.318
.*| . |	. | . |	16	-0.069	-0.042	17.436	0.358
. |*. |	. |*. |	17	0.090	0.098	18.169	0.378
. | . |	. | . |	18	0.061	-0.030	18.510	0.423
. | . |	. | . |	19	0.031	-0.050	18.600	0.483
.*| . |	. | . |	20	-0.074	-0.031	19.129	0.513
.*| . |	. | . |	21	-0.077	0.034	19.718	0.539
.*| . |	.*| . |	22	-0.081	-0.066	20.377	0.559
. | . |	.*| . |	23	-0.028	-0.080	20.456	0.614
. |*. |	. |*. |	24	0.133	0.142	22.338	0.559
. | . |	. | . |	25	0.042	0.027	22.529	0.605
. | . |	.*| . |	26	-0.051	-0.102	22.816	0.643
. | . |	. | . |	27	-0.045	0.016	23.045	0.683
. | . |	. |*. |	28	-0.008	0.101	23.052	0.730

Annex 9 Unit Root Test for Maize Prices in Nairobi: Feb 2008 to Jun 2011

Null Hypothesis: LN_NAIROBI has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.684752	0.7400
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.013285
HAC corrected variance (Bartlett kernel)	0.018776

Phillips-Perron Test Equation
Dependent Variable: D(LN_NAIROBI)
Method: Least Squares
Date: 06/30/11 Time: 21:05
Sample (adjusted): 2008M02 2011M06
Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_NAIROBI(-1)	-0.108665	0.080928	-1.342729	0.1873
C	0.643764	0.473398	1.359877	0.1819
@TREND(2008M01)	-0.000265	0.001647	-0.161156	0.8728

R-squared	0.046514	Mean dependent var	0.017660
Adjusted R-squared	-0.003670	S.D. dependent var	0.119506
S.E. of regression	0.119725	Akaike info criterion	-1.336882
Sum squared resid	0.544695	Schwarz criterion	-1.211499
Log likelihood	30.40609	F-statistic	0.926870
Durbin-Watson stat	1.691863	Prob(F-statistic)	0.404553

Null Hypothesis: D(LN_NAIROBI) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.516600	0.0003
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.014145
HAC corrected variance (Bartlett kernel)	0.015727

Phillips-Perron Test Equation
Dependent Variable: D(LN_NAIROBI,2)
Method: Least Squares
Date: 06/30/11 Time: 21:05
Sample (adjusted): 2008M03 2011M06
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_NAIROBI(-1))	-0.909855	0.166690	-5.458350	0.0000
C	0.010209	0.041439	0.246360	0.8068
@TREND(2008M01)	0.000313	0.001694	0.184876	0.8543

R-squared	0.446671	Mean dependent var	0.004111
Adjusted R-squared	0.416762	S.D. dependent var	0.161925
S.E. of regression	0.123662	Akaike info criterion	-1.270487
Sum squared resid	0.565817	Schwarz criterion	-1.143821
Log likelihood	28.40975	F-statistic	14.93401
Durbin-Watson stat	1.997808	Prob(F-statistic)	0.000018

Annex 10 Unit Root Test for Maize Prices in Mombasa: Feb 2008 to Jun 2011

Null Hypothesis: LN_MOMBASA has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.644314	0.7575
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.008741
HAC corrected variance (Bartlett kernel)	0.018389

Phillips-Perron Test Equation
Dependent Variable: D(LN_MOMBASA)
Method: Least Squares
Date: 06/30/11 Time: 21:03
Sample (adjusted): 2008M02 2011M06
Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_MOMBASA(-1)	-0.059886	0.070481	-0.849683	0.4008
C	0.351255	0.410294	0.856107	0.3973
@TREND(2008M01)	0.000180	0.001358	0.132593	0.8952

R-squared	0.023454	Mean dependent var	0.015381
Adjusted R-squared	-0.027943	S.D. dependent var	0.095786
S.E. of regression	0.097115	Akaike info criterion	-1.755478
Sum squared resid	0.358393	Schwarz criterion	-1.630095
Log likelihood	38.98731	F-statistic	0.456337
Durbin-Watson stat	1.350079	Prob(F-statistic)	0.637027

Null Hypothesis: D(LN_MOMBASA) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 5 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.803048	0.0021
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.008284
HAC corrected variance (Bartlett kernel)	0.011375

Phillips-Perron Test Equation
Dependent Variable: D(LN_MOMBASA,2)
Method: Least Squares
Date: 06/30/11 Time: 21:04
Sample (adjusted): 2008M03 2011M06
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_MOMBASA(-1))	-0.705373	0.156599	-4.504313	0.0001
C	0.007468	0.031636	0.236066	0.8147
@TREND(2008M01)	0.000225	0.001299	0.173089	0.8635

R-squared	0.354349	Mean dependent var	0.001635
Adjusted R-squared	0.319449	S.D. dependent var	0.114717
S.E. of regression	0.094636	Akaike info criterion	-1.805519
Sum squared resid	0.331371	Schwarz criterion	-1.678853
Log likelihood	39.11038	F-statistic	10.15326
Durbin-Watson stat	2.041128	Prob(F-statistic)	0.000305

Annex 11 Unit Root Test for Maize Prices in Nakuru: Feb 2008 to June 2011

Null Hypothesis: LN_NAKURU has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.122769	0.5182
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.010035
HAC corrected variance (Bartlett kernel)	0.025657

Phillips-Perron Test Equation
Dependent Variable: D(LN_NAKURU)
Method: Least Squares
Date: 06/30/11 Time: 21:06
Sample (adjusted): 2008M02 2011M06
Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_NAKURU(-1)	-0.093047	0.060023	-1.550182	0.1294
C	0.567404	0.349070	1.625475	0.1123
@TREND(2008M01)	-0.001109	0.001456	-0.761920	0.4508

R-squared	0.061088	Mean dependent var	0.021127
Adjusted R-squared	0.011672	S.D. dependent var	0.104668
S.E. of regression	0.104056	Akaike info criterion	-1.617424
Sum squared resid	0.411449	Schwarz criterion	-1.492040
Log likelihood	36.15718	F-statistic	1.236194
Durbin-Watson stat	0.957415	Prob(F-statistic)	0.301905

Null Hypothesis: D(LN_NAKURU) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.451523	0.0588
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.008104
HAC corrected variance (Bartlett kernel)	0.008357

Phillips-Perron Test Equation
Dependent Variable: D(LN_NAKURU,2)
Method: Least Squares
Date: 06/30/11 Time: 21:06
Sample (adjusted): 2008M03 2011M06
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_NAKURU(-1))	-0.491864	0.143880	-3.418576	0.0015
C	0.004085	0.031703	0.128844	0.8982
@TREND(2008M01)	0.000277	0.001287	0.215511	0.8306

R-squared	0.244283	Mean dependent var	0.000967
Adjusted R-squared	0.203433	S.D. dependent var	0.104872
S.E. of regression	0.093599	Akaike info criterion	-1.827561
Sum squared resid	0.324147	Schwarz criterion	-1.700895
Log likelihood	39.55121	F-statistic	5.980049
Durbin-Watson stat	2.290292	Prob(F-statistic)	0.005619

Annex 12 Unit Root Test for Maize Prices in Dar Es Salaam: Feb 2008 to Jun 2011

Null Hypothesis: LN_DAR_ES_SALAAM has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.572763	0.1069
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_DAR_ES_SALAAM)
Method: Least Squares
Date: 06/30/11 Time: 21:00
Sample (adjusted): 2008M03 2011M06
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_DAR_ES_SALAAM(-1)	-0.178146	0.069243	-2.572763	0.0142
D(LN_DAR_ES_SALAAM(-1))	0.473869	0.148085	3.199975	0.0028
C	1.000195	0.390210	2.563223	0.0146

R-squared	0.266618	Mean dependent var	-0.001939
Adjusted R-squared	0.226976	S.D. dependent var	0.094311
S.E. of regression	0.082920	Akaike info criterion	-2.069854
Sum squared resid	0.254399	Schwarz criterion	-1.943188
Log likelihood	44.39708	F-statistic	6.725600
Durbin-Watson stat	1.878006	Prob(F-statistic)	0.003226

Null Hypothesis: D(LN_DAR_ES_SALAAM) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.094761	0.0027
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_DAR_ES_SALAAM,2)
Method: Least Squares
Date: 06/30/11 Time: 21:01
Sample (adjusted): 2008M03 2011M06
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_DAR_ES_SALAAM(-1))	-0.626644	0.153036	-4.094761	0.0002
C	-0.003155	0.014056	-0.224472	0.8236

R-squared	0.306152	Mean dependent var	-0.005196
Adjusted R-squared	0.287893	S.D. dependent var	0.105276
S.E. of regression	0.088839	Akaike info criterion	-1.955276
Sum squared resid	0.299910	Schwarz criterion	-1.870832
Log likelihood	41.10553	F-statistic	16.76707
Durbin-Watson stat	1.755465	Prob(F-statistic)	0.000213

Annex 13 Unit Root Test for Maize Prices in Kampala: Feb 2008 to Jun 2011

Null Hypothesis: LN_KAMPALA has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.704662	0.7311
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_KAMPALA)
Method: Least Squares
Date: 06/30/11 Time: 21:02
Sample (adjusted): 2008M02 2011M06
Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_KAMPALA(-1)	-0.133644	0.078399	-1.704662	0.0964
C	0.779905	0.451157	1.728679	0.0920
@TREND(2008M01)	-0.001943	0.002406	-0.807524	0.4244

R-squared	0.071378	Mean dependent var	0.010507
Adjusted R-squared	0.022503	S.D. dependent var	0.168310
S.E. of regression	0.166406	Akaike info criterion	-0.678419
Sum squared resid	1.052254	Schwarz criterion	-0.553036
Log likelihood	16.90759	F-statistic	1.460418
Durbin-Watson stat	1.484436	Prob(F-statistic)	0.244874

Null Hypothesis: D(LN_KAMPALA) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.920887	0.0015
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LN_KAMPALA,2)
Method: Least Squares
Date: 06/30/11 Time: 21:02
Sample (adjusted): 2008M03 2011M06
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_KAMPALA(-1))	-0.788157	0.160166	-4.920887	0.0000
C	0.021114	0.057038	0.370180	0.7134
@TREND(2008M01)	-0.000514	0.002335	-0.220057	0.8270

R-squared	0.395745	Mean dependent var	0.001648
Adjusted R-squared	0.363082	S.D. dependent var	0.213594
S.E. of regression	0.170463	Akaike info criterion	-0.628559
Sum squared resid	1.075132	Schwarz criterion	-0.501893
Log likelihood	15.57118	F-statistic	12.11620
Durbin-Watson stat	1.956234	Prob(F-statistic)	0.000090

Annex 14 Unit Root Test on the Yearly Data (1980-2007) for Determinants of Maize Prices in Kenya

Table : Unit Root Test Results

	Level	
Variables	**ADF**	**PP**
NP	-1.2285	-1.3441
RP	-2.9410	-2.9453
QS	-0.0368	-0.8018
M3	-0.5038	-0.4973
RGDP	-1.0937	-1.2896
CPI	-0.9518	-0.9496
MS_RGDP	-0.4076	-0.3333
Critical Values		
1%	-3.6999	-3.6999
5%	-2.9763	-2.9763
10%	-2.6274	-2.6274
	First Difference	
ΔNP	-5.5747 *	-5.7454*
ΔRP	-5.5617 *	-10.0766*
ΔQS	-3.6403*	-8.6131*
ΔM3	-3.0152**	-3.0371**
ΔRGDP	-4.2236 *	-4.2644*
ΔCPI	-2.3349	-2.6654***
ΔMS_RGDP	-3.8060*	-3.8736*
Critical Values		
1%	-3.7115	-3.7115
5%	-2.9810	-2.9810
10%	-2.6299	-2.6299

Notes: (1) Asterisks (*), (**) and (***) indicate significant at 1%, 5% and 10% levels, respectively.

(2) For the ADF test, the optimal lag selection is based on Akaike Information Criterion (AIC) and for PP test it is based on Newey-West for Bartlett kernel.