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Staple Food Price Volatility and Its Policy Implications in Kenya

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Abstract

This paper evaluates the trends in staple food price volatility in Kenya for maize, wheat and Irish potatoes relative to three other Eastern Africa countries (Ethiopia, Tanzania and Uganda) using the unconditional and the conditional standard deviation. The paper tests the volatility of food prices during the global food crisis of 2007–2008. Using monthly wholesale prices data for maize, wheat and Irish potatoes in Kenya for the period January 2003 to February 2012, the paper estimates the conditional and unconditional price volatility and compares it with similar estimates from Ethiopia, Uganda and Tanzania.

Overall the volatility of commodity prices in Kenya as implied by the unconditional standard deviation is in the range of 12% to 32% with maize prices being the most volatile followed by Irish potatoes. Wheat prices are the least volatile in Kenya. Compared with the Eastern Africa region, maize and wheat markets in Kenya are more volatile than counterpart markets in Ethiopia, Tanzania and Uganda. Furthermore, Irish potato prices in Kenya are less volatile than markets in Ethiopia but more volatile than those in Uganda and Tanzania.

Given the persistent commodity price volatility in Kenya, this study recommends several policy options to deal with price volatility. These include supply response stimulating programmes such as governments buying surplus as buffer stock at competitive prices; input subsidy programmes; food for work programmes targeted to the poor working in agriculture; and establishing market information systems to avail better information about prices and stock levels.

1. Introduction

In recent months, global commodity markets have been characterized by very high price levels, but volatility—although high these past few years—is not out of line with historical experience and is generally lower than it was in the 1970s. While price levels refers to an index that traces the relative changes in the price of an individual good over time, price volatility measures the price variation or movement of a commodity over a given period of time (FAO 2007). The European Commission (EC 2009) and Matthews (2010) note that two forms of price volatility exist: a historical (realized) volatility and an implicit future volatility. The historical volatility relates to observed past prices and reveals how prices have varied in the past. It therefore serves as an indicator of future price changes for a commodity. In contrast, the implicit future volatility corresponds to the markets' expectation of how volatile a price will be in the future, as measured by the value of price options.

Several studies have been undertaken to explicitly elaborate some of the factors that explain recent evolution of price changes (Gilbert 2010; Gilbert and Morgan 2010). These studies have identified both market specific and general macro-economic determinants and explained how these factors have translated to demand and supply to explain the observed spikes. Most of them, however, do not differentiate between the endogenous and exogenous causes. A decline in the world food reserves, for example, is not an exogenous factor, hence cannot be considered as a primary driver of price spikes. Some studies therefore have divided the causal factors into three categories: root, intermediate and immediate causes (von Braun 2008).

Both theoretical and empirical evaluations seem to suggest that climate change from the supply side, biofuels production from the demand side and speculation in commodity futures from the market side are the three most important root causes of price volatility. The process is then reinforced by the prevailing production, exchange and growth conditions. Global economic growth, along with increased population, has further created favourable conditions for a fast response in trade flows and stock declines. Countries like China and India displayed remarkable income growth over the past two decades. The rise in income in these countries has increased per capita consumption and changed the consumption patterns.

In recent years several studies both within and outside the Eastern African region have investigated commodity prices volatility using the standard deviation, coefficient of variation (CV) and the more complex time series models. Karugia *et al*, (2010) uses the CV approach in a study to analyse trends in prices of key staple crops and livestock products in East African (EA) countries and world prices to test for food price volatility. The 2010 study by Karugia and others found that domestic prices were more volatile than the corresponding global prices. These findings are corroborated by Minot, (2010) who found that food prices were much more volatile in Sub-Saharan Africa than in other regions and much more volatile than commodity prices on international markets.

Gilbert and Morgan (2010) examine long-term trends in international food prices and find that volatility has been lower after 1990 than over the 1970–1989 periods. Furthermore, no long-term trends toward increased volatility were noted, but that the "implied volatility" associated with futures prices of wheat, maize and soybeans has been rising steadily since 1990 (OECD-FAO 2011). Volatile food prices are a major concern for governments, traders, producers and consumers. For example, price volatility of agricultural products is a major determinant of price profitability (Nijhoff and Chapoto 2009). Large price movements ("high volatility") are known to destabilize the exchange rates of a country and a prolonged volatile environment inhibits extraction of price signals from the market.

Gbegbelegbe and de Groote (2012) analysed the temporal and spatial maize price volatility from various markets in East Africa using monthly price data over the 1990 to 2010 period. The authors adopted the cointegration approach proposed by Rapsomanikis *et al*, (2004) and . find that real maize prices have decreased over time in Kenya. In addition, the study finds that price volatility has been decreasing over the years; presumably market liberalization has had a positive effect on this trend. This corroborates the results of the study done by Ariga *et al*, (2010) that show a decreasing trend in maize prices since 1995 with the partial withdrawal of the National Cereals and Produce Board (NCPB) from the maize market in Kenya.

High price volatility has been used to rationalize commodity stabilization programmes, such as price supports, buffer stock programmes and producer subsidies. More recently, Sarris (2000), among others have suggested using international hedge funds to manage the risk inherent in the volatility of commodity prices. However, as Sarris (2000) notes, such programmes require a sizable commitment of resources. Moreover, high and volatile food prices are not a new phenomenon to such households (Chambers *et al.*, 1981).

This paper evaluates the trends in staple food price volatility in Kenya relative to three other Eastern Africa countries (Ethiopia, Tanzania and Uganda). The paper tests the hypothesis that food prices have become more volatile since the global food crisis of 2007–2008. The objective of the paper is twofold: first a quantification of conditional price volatility; and secondly a price transmission analysis to test the effect of world prices on domestic prices.

The paper is structured into six sections: section 1 gives the background of the study, section 2 reviews the causes and measures of price volatility. In section 4, the methodological approach adopted is presented. Section 5 presents the results of the study and discusses their economic implications. This is followed by a review of the coping strategies adopted by the Kenya Government in response to the food price volatility. Finally, a summary of the major findings, conclusions and policy recommendations are presented in section 7.

2. Causes and measures of food price volatility

An extensive discussion of some of the factors causing a change in the volatility of prices in international commodity markets is presented by Moledina *et al.*, (2004). The authors categorize the causes of international price volatility into micro-economic and macro-economic arguments. The classic micro-economic argument for increasing volatility relies on unexpected market shocks. Ng and Ruge-Murcia (1997) extend the competitive storage model to show that volatility and the persistence of shocks to prices may increase if: (i) there are long gestation lags in production with heteroskedastic supply shocks; (ii) forward multi-period contracts that overlap provide unanticipated additional sources of supply in every period; or (iii) there is a convenience return to holding inventories.

Aside from obvious weather effects, short-term volatility can also increase in the presence of large-scale entry-and-exit into global markets or from the unpredictable behaviour of state traders. This argument suggests that the structure of the market and the degree of government intervention can alter volatility over time. The macro-economic argument typically appeals to the idea that increased trade, capital flows and policy shocks to macro-economic variables such as the terms of trade and exchange rate uncertainty, affect agricultural commodity prices (Mitchell, 1987). While existing evidence shows that exchange rates affect commodity prices for *certain* agricultural commodities and *certain* countries, it is still open to debate whether the magnitude of the effects are small or large see Cho *et al.*, (2002) for one perspective and Moledina *et al.*, (2004) for another.

Obviously the links between international prices and local prices are complicated. The first determinants of how international prices translate into site specific prices relate to exchange rate movements and a country's net trade position. Furthermore, the existing domestic trade policies and the manner of their implementation often determine the extent to which individual producers are able to respond to market signals. Local price movements, meanwhile, reflect a multitude of factors including weather conditions, shifts in local production, disease and consumption shocks, inflation, changing informal trading patterns among others. However, that said, a cursory review of monthly price movements in Kenya reveals a trend of puzzling persistently high and increasingly variable food prices. These have a negative effect on the country's food security.

Food prices in the Eastern Africa region have become more volatile in recent years (G20 2011; Gérard *et al*, 2011). For Kenya, the 2007 post-election events compounded the crisis, culminating in an unprecedented price increase and the fuelling of volatility. The Kenyan food price movements are heavily dependent on rainfall patterns since Kenyan agriculture is largely rainfed and vulnerable to the effects of climate change. On average, climate change may push world food prices about 35% higher by 2050 (Nelson *et al.*, 2009). The main downward turns in food prices coincide with arrival of the long-rain season harvest which constitutes close to 85% of the national maize output. Abbott *et a.l*, (2011), however, believe that supply factors are weak explanations of price volatility at the global level. This is because commodity specific shocks can easily be compensated for across a wide range of geographic regions. Europe's poor grain harvest in 2007, for example, was offset by a good harvest in Argentina, Kazakhstan and Russia (Abbott *et al.*, 2011).

Controversies, however, exist on whether the role of speculation in the futures and options trading on the food commodity markets can be termed as other factors that influence price variability. While some studies (Gilbert and Morgan 2010) highlight them as influential factors, Irwin and Sanders (2011) do not support this view. According to the IFPRI Hunger Index 2011, which focuses on price volatility, futures trading is used by agricultural producers to reduce the risk they face from changing prices, and by speculators to take advantage of price shifts in commodities (IFPRI 2011).

With regard to the measurement of price volatility, several historical volatility measurements have been used in the literature. Economists have used measures based on the price levels. They have focused on the standard deviation of prices or of logarithmic prices or on CV which expresses the standard deviation as a percentage of the sample mean. The main advantage of CV is that it does not depend on the unit of measurement. Moreover, some measures consider that most economic series exhibit some form of trend, and permit the removal of trend movements in the volatility measures.

In dealing with data nonstationarity, some authors use the standard deviation of the first difference in the logarithmic value of prices (e.g. Clem 1985; Gilbert 2006; EC 2009; Jacks *et al*, 2009; Gilbert and Morgan 2010) and some others recommend the use of "de-trended" series to compute volatility measures (e.g. Cuddy and Della Valle 1978; Matthews 2010). The advantage of the first computation is its simplicity; using de-trended series means that a model is required to take into account or approximate the nature of the underlying trend. In this way, the main drawback is that the volatility measure may depend on the choice of the de-trending technique. For example, Cuddy and Della Valle (1978) proposed a corrected CV, based on linear and log-linear trend. Other authors resort to regression analysis to estimate volatility models (Moledina *et al.*, (2004); and Rapsomanikis *et al*, (2004)).

Gilbert and Morgan (2010), for example, estimate a Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model which is often used to model volatility in financial markets. The idea is to estimate the conditional variance of innovation from the auto-regressive process followed by a time series. However, the interpretation of the volatilities computed with such a measure poses some questions. Besides, parameters underlying this kind of model are not always well determined. Finally, the question is whether to compute the volatility on nominal or real prices. However, in the case of real prices, it means that we have to deflate a series and this introduces another uncertainty in the measure of volatility. Indeed there is no consensus on the best deflator to use and the choice is always constrained by the availability of data.

Moledina *et al.,* (2004); and Rapsomanikis *et al*, (2004) adopt a framework that proceeds in at least two steps with variations. In both cases, the first step entails evaluating the time series properties of the data. This is followed by an estimation of regression model either an Autoregressive Conditional Heteroscedasticity (ARCH) as in the case of Moledina *et al.,* (2004) or a Vector Error Correction Model (VECM) as in the case of Rapsomanikis *et al*, (2004) and Minot, (2010). Both approaches yield intuitively appealing results that are more robust than the tradition coefficient of variation that has been frequently used to estimate price volatility.

4. Study approach

This study employs regression approaches to evaluate volatility. It adopted the approach proposed by Moledina *et al.,* (2004) to quantify the unconditional and conditional price volatility for maize, wheat and Irish potatoes in Kenya. In addition, it adopts the VECM approach proposed by Rapsomanikis *et al*, (2004) and applied by Minot, 2010 to assess the effect of changes in world food prices on domestic food markets in Kenya and Ethiopia.

4. 1. Autoregressive Models of Price Volatility

Following Moledina *et al.,* (2004), the price volatility analysis proceeds in steps as illustrated in Figure 1. To evaluate the time series properties of the price data, unit root tests were performed using the Phillips-Perron (PP) test. If the null hypothesis of a unit root cannot be rejected, the data are differenced and tested for stationarity. Similarly if enough evidence exists to reject the hypothesis of unit root then the series remain in levels. The number of times that the series is differenced to make it stationary indicates its order of integration I(d) and value of d in Autoregressive Integrated Moving Average (ARIMA) models (ARIMA) (p, d, q) process.

After the level of differencing is determined, the Box-Jenkins methodology along with the Akaike Information Criteria (AIC) are applied to the differenced (or undifferenced) series to select the values of p and q in the ARIMA (p, d, q) process. Since commodity prices volatility is known to be time varying, the assumption of homoscedasticity on the residuals is tested for next using the Autoregressive Conditional Heteroscedasticity-Langrage Multiplier (ARCH-LM) test developed by Granger (1988). This is done by estimating a regression of the squared residuals on constant and lagged residuals up to the order q. The ARCH-LM test statistic is the number of observations multiplied by the R^2 from the test regression and is asymptotically distributed $\chi 2$ (q). If the null hypothesis of no ARCH effects cannot be rejected using the ARCH-LM test, an ARIMA model for those commodities prices is next estimated (Figure 1). When the null hypothesis of no ARCH is rejected, an Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) model for each market commodity price is estimated.

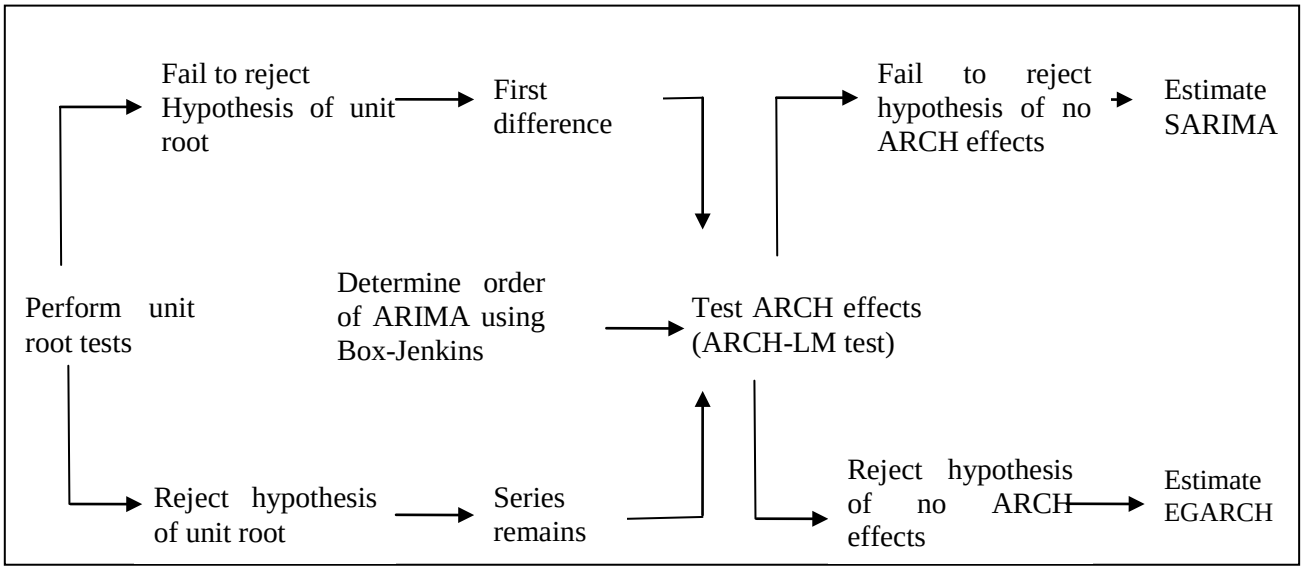

Figure 1: Flow chart of methodology to compute conditional volatility
Source: Moledina *et al.*, (2004).

Following Sarris (2000), the ARIMA model is specified as follows:

$$X_t = \mu + \sum_{i=1}^{p} \gamma_i X_{t-i} + \varepsilon_t + \sum_{j=1}^{q} \vartheta_j \varepsilon_{t-j} \qquad 1$$

where X_t is the dependent variable, X_{t-1} for i= 1,….,p are lagged dependent variables; ε_t is the error term and assumed to be white noise; ε_{t-j}, j=1,…,q are lagged error terms; t denotes the time period and μ is the mean.

The autoregressive coefficients γi and moving average coefficients ϑ_j are parameters to be estimated. The error terms are assumed to be a normally distributed with a mean of zero and constant variance σ^2. When differenced say d times, the process becomes ARIMA process of order (p, d, q). An integrated process is one that needs to be differenced to achieve stationarity. Thus, a process X_t is integrated of order I(d) if it contains no deterministic components, is non-stationary in levels but becomes stationary after differencing d times.

Following Engle (1982), the ARCH (q) model is specified as:

$$Y_t = X_t \beta + \varepsilon_t \qquad 2$$

where $\varepsilon_t \big| \Omega_{t-1} \approx N(0, h_t)$

$$h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-1}^2 \qquad 3$$

where ε_t is the error component in the ARCH model; h_t is the time varying variance of the error; Ω_{t-1} is the information set for the whole period *t-1*; β, α_i for *i=1, 2, 3…, q* and ω are parameters to be estimated. The ε_t are not serially correlated although their dependency relies on the evolution of the variance.

However, the Generalized Autoregressive Conditional Heteroscedasticity (GARCH is the time-varying variance. It is autoregressive because it depends on the observations of the immediate past while conditional means it incorporates past observations into the present.

Hence GARCH is a mechanism that includes past variance in the explanation of future variances and is used to model the serial dependence of volatility. The GARCH process is presented following Modelina *et al*, (2004) where the lagged variance is allowed to enter the model:

$$h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon^2{}_{t-i} + \sum_{j=1}^{p} \gamma_j h^2{}_{t-j} \qquad 4$$

with γ_j for j=1,2,…,p as additional parameters, where

$p \geq 0, \quad q \geq 0$

$\omega > 0, \quad \alpha_i \geq 0, \; i=1...q$

$\gamma_j \geq 0, \quad j=1,.....,p$

where p is the order of GARCH and q is the order of ARCH process. For $p = 0$ the process reduces to the ARCH (q) process, and for $p = q = 0$, ε_t reduces to white noise. In the ARCH (q) process, h_t is a linear function of past sample variances while in GARCH (p, q) process, h_t allows lagged conditional variances to enter the variance equation as well. The ARCH (q) model is considered to have a short memory because only most recent residuals have an impact on the variance. The GARCH model has a long memory process because all past residuals can affect the current variance either directly or indirectly through the lagged variance term. The GARCH estimates have been used to identify periods of high volatility and volatility clustering. The sum of $\alpha_i + \gamma_j$ gives the degree of persistence of volatility in the series. If the sum is close to 1, it means volatility tends to persist for a longer period.

If the sum exceeds 1, it indicates an explosive series with a tendency to meander away from the mean value (O'Connor and Kean 2011). However, problems arise due to the non-negativity constraint imposed on the parameters. Recognizing this, Nelson (1991) introduced the Exponential GARCH models. The Exponential-GARCH models were designed to capture the leverage effect and a simple variance equation of EGARCH is given by:

$$\ln h_t^2 = \omega + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \alpha \left(\left[\left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| \right] - \sqrt{\frac{2}{\pi}} \right) + \beta \ln\left(\sigma^2{}_{t-1}\right) \qquad 5$$

This is a generalization of the GARCH (1,1) model designed to capture leverage effects/asymmetry while allowing conditional variance to depend upon its previous lags. *ln* h_t is the conditional variance to be modelled. The natural logarithm ensures that variance at time t is positive even when parameters are negative. γ measures asymmetry/leverage effect - price response to market shocks- unanticipated changes in prices; α measures symmetric effect/sensitivity of volatility to market events; β measures persistence in conditional volatility and ω is the constant. To capture the leverage effect, this study estimates ARIMA and EGARCH models of price volatility.

4. 2. Vector Error Correction Models of Price Transmission

The price transmission analysis is undertaken following the approach proposed by Minot (2010), which is only interested in one portion of the Vector Error Correction Model (VECM). The model to be estimated is specified as follows:

$$\Delta p_t^d = \alpha + \theta\left(p_{t-1}^d - \beta p_{t-1}^w\right) + \delta \Delta p_{t-1}^w + \rho \Delta p_{t-1}^d \qquad 6$$

where: p_t^d is the log of domestic price converted to real US dollars; endogenous variable, p_t^w is the log of world price of the same commodity in real US dollars; exogenous variable, Δ is the difference operator, so $\Delta p_t = p_t - p_{t-1}$, α, θ, β, δ, and ρ are estimated parameters, and ε_t is the error term.

Following Minot (2010) the coefficients in the error-correction model and their expected value and signs can be interpreted as follows: the co-integration factor (β) is the long-run elasticity of the domestic price with respect to the international price. β is the long-run elasticity of price transmission. The expected value for imported commodities is $1 > \beta > 0$, Thus, if $\beta = 0.5$, this implies that 50% of the proportional change in the international price will be transmitted to the domestic price in the long run. The error-correction coefficient (θ) reflects the speed of adjustment. It is normally expect to fall in the range of $-1 < \theta < 0$. The term in parentheses represent the deviation or "error" between the prices in the previous period and the long-run relationship between the two prices.

If the error is positive (the domestic price is too high given the long-term relationship), then the negative value of θ helps "correct" the error by making it more likely that the Δp_t^d is negative. The larger θ is in absolute value (that is, the closer to -1), the more quickly the domestic price (p^d) will return to the value consistent with its long-run relationship to the world price (p^w). The coefficient on change in the world price (δ) is the short-run elasticity of the domestic price relative to the world price. In this case, it represents the percentage adjustment of domestic price one period after 1% shock in international price. The expected value is $0 < \delta < \beta$. The coefficient on the lagged change in the domestic price (ρ) is the autoregressive term, reflecting the effect of each change in the domestic price on the change in domestic price in the next period. The expected value is $-1 < \rho < 1$.

4. 3. Data Sources

The study uses monthly wholesale price data for maize, wheat and Irish potatoes in Kenya for the period January 2003 to February 2012 and compares it with commodity prices in three other Eastern Africa countries (Ethiopia, Tanzania and Uganda). The price data were obtained from the following sources: Ethiopia Grain Enterprise Council for maize and wheat prices in Ethiopia; Central Statistical Agency Ethiopia for potatoes prices in Ethiopia; Kenya Ministry of Agriculture for maize, wheat and potatoes prices in Kenya; Bank of Tanzania for maize and potatoes in Tanzania; and Uganda National Bureau of Statistics for maize and potatoes in Uganda. SAFEX provides South Africa data which were used to give a Southern Africa comparison with Eastern Africa countries.

3. Results

Table 1 presents the estimates of commodity price volatility in Kenya using the unconditional standard deviation (CV) and the conditional standard deviation based on estimates of the ARIMA and EGARCH models of price volatility. As standard practice in time series modelling, the data were tested for unit roots using the PP test. All price variables are transformed to logarithms while the prices used are real. The hypothesis of a unit root in the level series cannot be rejected at the 5% significance level for any of the series in both models (Table 1). However, the first differenced series reject non-stationarity in all cases implying that the data is integrated of order 1. These results are consistent with the hypothesis that non-stationarity characterizes the price series used in estimating price volatility in this study.

Table 1. Estimates of commodity price volatility in Kenya

Commodity	Standard deviation	Unconditional standard deviation	Conditional standard deviation	Unit root present?
Maize	0.120	0.324	0.282	Yes
Wheat	0.182	0.216	0.169	Yes
Irish potato	0.152	0.234	0.120	Yes

Source: Authors Computations

Similarly, the ARCH-LM test, rejects the null hypothesis of no ARCH effects for all commodity price series in Kenya at the 5% significance level indicating that commodity prices in Kenya vary over time and that the EGARCH model could be used to derive a conditional standard deviation that is used as a measure of price volatility. For all commodities in Kenya, the conditional volatility was substantially lower than the unconditional volatility (Table 1).

Commodity price volatility in Kenya, as implied by CV (unconditional standard deviation), was highest for maize (32%) and lowest for wheat (22%) (Table 1). Removing the predictable component reduced the volatility in the maize and wheat series to 28% and 12% respectively (Table 1). These findings suggest that the most volatile commodity prices in Kenya were those for maize followed by Irish potatoes and then wheat. However, the conditional standard deviation suggests that staple commodity prices in Kenya are not as volatile as suggested by CV. Overall the volatility of commodity prices in Kenya was in the range of 12% to 32% (Table 1).

Table 2 presents the estimates of staple commodity price volatility in the Eastern Africa region relative to international prices. Following Sarris (2000), all price series are differenced regardless of whether they reject the hypothesis of a unit root. The differencing is justified when considering the low power of the PP test in small samples and in cases where structural breaks might exist. The large unconditional standard deviation of the SAFEX and Uganda maize prices as compared to the other series is an indication that SAFEX and Uganda maize prices are more volatile followed by Kenya, Ethiopia, Tanzania and finally the FAO Global maize prices (Table 2). This finding is unexpected since Uganda is a net producer of maize.

Table 2. Estimates of commodity price volatility in Eastern Africa

Commodity	Standard deviation	Unconditional standard deviation	Conditional standard deviation	Unit root present?
Maize				
Kenya	0.120	0.324	0.282	Yes
Uganda	0.157	0.474	0.157	No
Tanzania	0.086	0.293	0.080	No
Ethiopia	0.095	0.477	0.094	No
SAFEX	0.236	0.261	0.211	Yes
FAO	0.066	0.395	0.069	Yes
Wheat				
Kenya	0.182	0.216	0.169	Yes
Tanzania	0.183	0.281	0.168	Yes
Ethiopia	0.064	0.297	0.058	Yes

FAO	0.091	0.246	0.079	Yes
Irish potatoes				
Kenya	0.152	0.234	0.120	Yes
Uganda	0.133	0.130	0.110	Yes
Tanzania	0.083	0.141	0.076	Yes
Ethiopia	0.141	0.279	0.136	Yes

Source: Authors Computations

However, the conditional standard deviation results show that maize prices in Kenya were the most volatile in the region and compared to the FAO global prices as indicated by the high average conditional standard deviation (0.282) followed by SAFEX, Uganda and Ethiopia; Tanzania had the least volatile maize prices (Table 2). Moreover, when the volatility of the Eastern Africa maize prices is compared with the volatility of international maize prices as represented by the FAO maize prices, the global maize prices are less volatile than the Eastern Africa region.

The finding that Eastern Africa maize prices are more volatile than the global maize markets is consistent with the finding of Mitchell (2008) who attributes most of the volatility in commodity prices to macro-economic and political instability. Over the study period, Ethiopia and Kenya experienced droughts that necessitated massive importation of grain, draining foreign exchange reserves and destabilizing the countries' macro-economic status. In addition, Kenya and Tanzania imposed maize export bans that restricted supply and had a negative impact on macro-economic stability. In 2008 Kenya experienced post-election violence. The effect of this political conflict was a restriction in supply that caused an imbalance in Kenya's macro-economic factors.

A close inspection of the conditional volatility for maize shows that all series were excessively peaked as evidenced by the excess kurtosis, especially in the maize price series for Kenya (Figure 2). The excess kurtosis suggests that the distribution for most commodities is highly leptokurtic, which implies large changes follow even larger changes and small changes follow smaller changes. Such leptokurtic changes are indicative of ARCH disturbances. According to Cashin *et al.*, (1999), such persistent volatility can affect the cost of commodity price stabilization programmes.

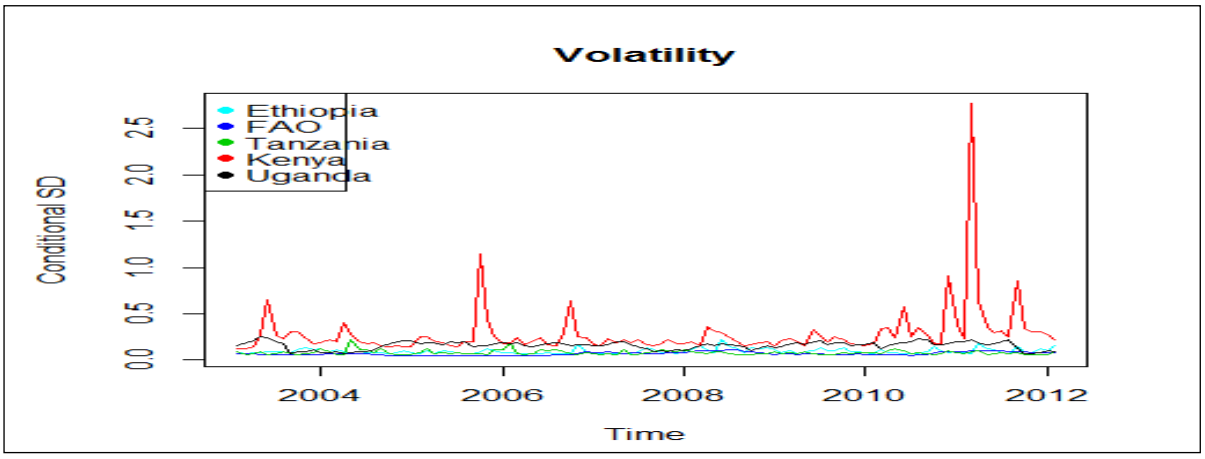

Figure 2: Volatility of the maize prices
Source: Author computation.

This has been experienced in Kenya where, in response to the food price crisis in 2008, the government procured maize from the domestic market through NCPB largely due to pressure being exerted by consumers following high maize meal prices. Although the government set a high price of KSh 1,750 per 90 kg bag, farmers held on to their stocks in anticipation of higher market prices later in the season. Farmers demanded a 20% price increase to KSh 2,200 per 90 kg bag. Over the same period the government increased the producer price from KSh 1,750 per 90 kg bag to KSh 1,950 making the cost of maintaining a strategic grain reserve exorbitantly high and out of sync with international maize prices.

Wheat prices in the Eastern Africa region are less volatile than maize prices, but more volatile than Irish potato markets. The unconditional price volatility suggests that wheat prices are highly volatile in Ethiopia (30%) followed by Tanzania at 28%, and least volatile in Kenya at 22% (Table 2). The large unconditional standard deviation in Ethiopia and Tanzania as compared to the other series is an indication prices in these two countries are more volatile followed by FAO Global and finally Kenya.

However, the conditional price volatility seems to suggest that the volatility of wheat prices in the Eastern Africa region is in the range of 6% in Ethiopia to 17% in Kenya and Tanzania as compared to 8% in the global market (Table 1). This is expected given that most of the wheat consumed in the East African region is imported from the world market. Kenya's wheat price volatility is in the range of that reported in Tanzania perhaps as a result of the application of a common external tariff in the East African Community. Ethiopia is not a member of this Community and applies different import rules.

The prices of Irish potatoes, a non-tradable commodity, are the least volatile in the Eastern Africa region. The unconditional standard deviation reports Irish potato price volatility to be in the range of 13% in Uganda to 28% in Ethiopia (Table 2). However, the conditional price volatility indicates that the volatility of Irish potato prices is highest in Ethiopia (13%), followed by Kenya (12%) and Uganda (11%); it is lowest in Tanzania at 8% (Table 2). These volatility trends seem to suggest that the Eastern Africa region is insulated from other Irish potato markets and as a result volatility is low. The persistently high food price volatility in Kenya and the Eastern Africa region despite the precipitous decline in international prices raises concern from a food security perspective. These persistently high food prices indicate a poor degree of price transmission from international markets to domestic markets in Kenya.

A price transmission analysis is therefore undertaken next to unravel the causes of the persistently high and volatile commodity prices in Kenya and the Eastern Africa region. Table 3 provides a summary of the results for the transmission of international maize and wheat prices to domestic markets for seven price series in Ethiopia, Kenya, Tanzania and Uganda. The Augmented Dickey Fuller (ADF) test and PP show that the hypothesis of a unit root cannot be rejected in six out of the seven price series (Table 3). This implies that the price series for maize and wheat are non-stationary in the four countries except for maize in Tanzania. Given that the price series are non-stationary, the long-run relationship between the domestic market prices and international market prices are analysed using the Johansen's cointegration test.

The cointegration analysis results show that out of the seven price series, only two wheat price series (Ethiopia and Kenya) have a significant long-run relationship with international wheat prices (Table 3). The elasticities of price transmission for wheat prices in Ethiopia and Kenya were about 0.11 and 0.25 respectively (Table 3).

Table 3: Transmission of world food prices to domestic prices in Kenya

		Unit root test		Long-run relationship	Error Correction Model		
Country	Commodity	ADF	PP	Johansen test (cointegration)	Speed of adjustment	Short-run adjustment	Long-run adjustment
Kenya	Maize	No	Yes	No			
Kenya	Wheat	No	Yes	Yes	-0.452***	-0.285	0.249***
Ethiopia	Maize	Yes	No	No			
Ethiopia	Wheat	Yes	Yes	Yes	-0.050***	-0.088	0.107***
Tanzania	Maize	No	No	No			
Tanzania	Wheat	Yes	Yes	No			
Uganda	Maize	Yes	No	No			
*** significant at 1% level							

Source: Authors Computations

These estimates imply that 11% of the changes in international wheat prices are transmitted to markets in Ethiopia while 25% of the changes in world wheat prices are transmitted to Kenya.This is expected given that Kenya is a net wheat importer that regularly imports maize through the port of Mombasa that is well connected to Nairobi by both road and rail. Similarly, the speed of adjustment of domestic prices to the long-run relationship was 0.05 and 0.45 in Ethiopia and Kenya respectively (Table 3). This implies that domestic wheat prices in Ethiopia take about 20 months to fully adjust to changes in world prices; they take about 2 months to fully adjust to changes in world wheat markets in Kenya.

4. Government response to food price volatility in Kenya

In response to the volatility of staple commodities, the Kenya Government adopted direct market intervention measures and some supply side policy options to cope with the persistent volatility. A comprehensive discussion of these responses based on media reports are reported in Meijerink *et al.*, (2009). These included price support through NCPB, buffer stockholding, input subsidy programmes, export bans, duty free importation and the design of irrigation schemes, the economic stimulus programme and physical infrastructure works.

Before the 2007/2008 food price crisis, the Government of Kenya intervened in markets through NCPB operations and by imposing import tariffs on food imports. Although NCPB is responsible for maintaining a strategic grain reserve, its food procurement activities have the effect of stabilizing market prices. However, imposing food import tariffs that were in the range of 25% to 50% over the 2000 to 2005 period had the effect of limiting imports and increasing domestic prices.

After the food price crisis, the Kenya Government implemented export restrictions on maize in 2008 and embarked on an aggressive importation of maize through NCPB to build up stocks for the national strategic grain reserve. At the start of 2008, the government had licensed large-scale traders to export maize to neighbouring countries such as South Sudan. Much of these maize exports were procured from trader stocks and the strategic grain reserve. When it became clear the national strategic reserve was depleted and supply was constrained by the impacts of the post-election crisis and drought, the government imposed an export ban on maize. In response to the drought experienced in the region, Kenya, Malawi and Tanzania imposed maize export bans.

As the crisis worsened and the imports failed to arrive on time, the government turned to domestic procurement through NCPB largely as a result of pressure being exerted by consumers following high maize meal prices. Although the government set a high price of Ksh 1,750 per 90 kg bag, farmers held on to their stocks in anticipation of higher market prices later in the season. They demanded a 20 percent increase to KSh 2,200 per 90 kg bag. The government over the same period increased the producer price from KSh 1,750 per 90 kg bag to KSh 1,950, but directed the NCPB to sell the same to millers at KSh 1,750. This translated to a producer subsidy of KSh 200 per 90 kg bag.

The government maize imports did not arrive until March 2009. Moreover, the distribution of the subsidized maize to millers was flawed. NCPB imports were sold to briefcase traders posing as maize millers who were licensed to procure grain from NCPB in an effort to support a maize meal subsidy programme pioneered by the Prime Minister (see discussion under consumption subsidies). This undermined the effect of the subsidy programme. In addition, NCPB sold the subsidized maize only in bundles of 50 kg making it too expensive for the poor.

The export restriction may have been ineffective given the existence of substantial informal cross-border trade with the country's neighbours. Despite the export ban on agricultural commodities in Tanzania, substantial volumes of maize were exported into Kenya in 2009. Although export restrictions are aimed at protecting consumers by keeping the price low, they potentially increase transaction costs through informal trade routes, effectively hurting consumers. Jayne *et al.,* (2005) observe that export bans increase smuggling costs, depress producer prices and raise consumer prices.

Other trade policies adopted included reducing import tariffs and taxes on maize and wheat. In June 2008, import duty on wheat was reduced by 25% (from 35% to 10%) and that of maize was zero-rated after the Ministry of Agriculture intervened. Other fiscal measures included zero-rating value-added on wheat and maize flour, and milk. Despite these efforts, the price of maize continued to rise and by October/November 2008, the government shifted its strategy to direct protection of consumers through food subsides. This decision followed near food riots in Nairobi.

While universal food subsidies are ideal as a quick response to improve access to food and to mitigate the initial impacts of a price surge, they are costly and often fail to target those most in need. In December 2008, the Kenya Government adopted a direct consumer price subsidy by introducing a dual pricing system for maize meal. This urban maize meal subsidy programme was the brainchild of the Prime Minister, whose urban constituency covers Kibera, the largest slum in Nairobi. The Ministry of Finance initially opposed the subsidy programme, but implemented it later. A 2 kg packet of maize meal was supposed to sell at a commercial rate of KSh 72 and a subsidized rate of KSh 55. The lower price was supposed to benefit the poor. The subsidy programme was largely supported by the milling industry that was licensed to procure maize from NCPB, mill it and sell it at subsidized prices and later apply for rebates from the Ministry of Finance.

Other than transporting the subsidized meal to the informal settlements and other low income neighbourhoods, no other targeting criteria were implemented. Furthermore, the subsidized pack was retailed in 5 kg bags which made it inaccessible to the poor. Within a short period, the urban maize meal subsidy programme became untenable owing to financing and distribution bottlenecks and was eventually discontinued. The programme raised some

political overtones given the composition of the grand coalition government: the Prime Minister who supported the programme came from one wing of the coalition while the Minister for Finance came from another wing of the coalition which opposed the subsidy.

The cost of the scheme was estimated at KSh 23.4 billion (US$ 334 million) in subsidy and tax foregone in the 2008/09 fiscal year. After a critical analysis, the Cabinet withdrew the scheme in February 2009 and committed to develop an alternative more effective scheme. In the meantime, the price was left to market fundamentals. In addition, the Cabinet directed the relevant ministries to work with interested donor agencies to develop a comprehensive food subsidy programme.

Another initiative implemented by the government was a cash for work programme named *Kazi Kwa Vijana* (KKV), mooted by the Prime Minister. In an environment of increasing food prices, such public work programmes increase the income of the poor and improve their access to food. The large number of unemployed youth in the country made such an intervention attractive. The KSh 15 billion (US$ 214 million) KKV programme was launched in March 2009 and aimed to create 300,000 jobs within 6 months of its launch. The programme engaged the unemployed youth in infrastructure work (mainly roads) and environmental conservation exercises such as tree planting and river cleaning efforts. The programme, although bedevilled by payment problems, was successful in building some assets, notable being the clean-up of the Nairobi River.

In an effort to stimulate supply response the government, through NCPB, entered the farm inputs (fertilizer and maize seeds) markets in 2000 with an aim of boosting the Board's revenue and stabilizing the fertilizer prices in the local market. However, following the surge in fertilizer prices in 2008, the government bought 163,000 metric tons or 40% of the national fertilizer requirement at a cost KSh 6.2 billion (US$ 89 million). This excluded the tea fertilizer bought by the Kenya Tea Development Agency (KTDA) worth KSh 1.6 billion.

In March 2009, the President announced that diammonium phosphate (DAP) fertilizer would sell at a reduced price of KSh 2,500 while calcium ammonium nitrate (CAN) fertilizer would retail at KSh 1,650 per 50 kg bag from a high of KSh 6,000. The price of seed was also reduced by KSh 50 and KSh 10 per 10 kg packet and 2 kg packet respectively. Just like the interventions in the maize market, the implementation of the input subsidy also encountered governance challenges. Once again, some unscrupulous traders procured the fertilizer from NCPB, repackaged it and sold it to unsuspecting farmers at higher prices than those recommended by government. This was in addition to the potential disruptions of the fertilizer business. Smuggling was rife at the Kenya–Uganda border as fertilizer prices were higher in Uganda than they were in Kenya.

Realizing that resource poor farmers, especially those in the lowlands, may not have the know-how or cannot afford purchased inputs, the Kenya Government embarked on a National Accelerated Agricultural Input Programme (NAAIAP). The programme aimed to promote food security and reduce poverty. Initially planned to subsidize fertilizers and maize seed for a limited number of districts, it was subsequently expanded to national coverage with plans to provide 2.5 million farmers with maize seed and fertilizers for 1 acre each. Vouchers were issued to targeted farmers (with less than 2.5 acres) and subsequent redeemed through private input sellers who would also be eligible for trade credit guarantees. .

Farmers under this input grants popularly known as *Kilimo* Plus. Starter kits are supposed to be linked to extension, cereal banks, warehouse receipts, and participation in farmer groups. These farmers are supposed to graduate after two years into another programme: *Kilimo Biashara* (farming as a business). The expected graduation is yet to successfully materialize due to the poor harvest in late 2007 and in 2008. The programme received a financial boost from FAO and the World Bank in 2008 in response to the high food prices. *Kilimo Biashara* was launched in May 2008 as a US$ 50 million (KSh 3 billion) loan project. Probably encouraged by the successful experience in Malawi with fertilizer and seed subsides, the Kenya Government in partnership with the Alliance for a Green Revolution (AGRA), IFAD and Equity Bank launched the project with aim of targeting small-scale farmers and enterprises in the agricultural value chain.

AGRA catalysed the project by setting up a US$ 5 million (KSh 400 million) "cash guarantee fund". The fund buffers Equity Bank's risk of lending money to farmers and small agricultural businesses with little or no collateral. The loans carry a 12% interest rate applied when the loans fall due, a rate well below the bank's standard lending rate of 18% (as per 2008). Under the programme, farmers are also trained in improved farming techniques and business management in addition to receiving government vouchers that enable them to purchase new farming inputs. Another government response came in form of an economic stimulus package to agriculture through revival of the stalled Hola irrigation scheme in the lower Tana River Delta. In September 2008 the President and the Prime Minister launched a KSh 2 billion National Economic Stimulus Programme on food production in the irrigation scheme. However, plans to market the output were lacking as extensive post-harvest losses were recorded in February 2010.

5. Conclusions

While food prices have increased substantially since 2007, the evidence on food price volatility is mixed. Volatile food prices are a major concern for governments, traders, producers and consumers. This paper evaluates the price volatility of maize, wheat and Irish potatoes in Kenya relative to three other Eastern Africa countries (Ethiopia, Tanzania and Uganda) using the unconditional and the conditional standard deviation. Using monthly wholesale price data for maize, wheat and Irish potatoes in Kenya for the period January 2003 to February 2012, the paper estimates the conditional and unconditional price volatility.

Commodity price volatility in Kenya, as implied by CV (unconditional standard deviation) was highest for maize (32%) and lowest for wheat (22%). Overall, the volatility of commodity prices in Kenya was in the range of 12% to 32%. These findings suggest that the most volatile commodity prices in Kenya are those for maize followed by Irish potatoes and then wheat. Maize prices in Kenya as indicated by the high average conditional standard deviation were the most volatile in the East African region followed by SAFEX, Uganda and Ethiopia; Tanzania had the least volatile maize prices. Moreover, when the volatility of the Eastern Africa maize prices was compared with the volatility of international maize prices, the global maize prices were less volatile than those in Eastern Africa.

Wheat prices in the Eastern Africa region are less volatile than maize prices but more volatile than Irish potato markets. The unconditional price volatility suggests that wheat prices are highly volatile in Ethiopia (30%) followed by Tanzania at 28%; they are least volatile in Kenya at 22%. The prices of Irish potatoes, a non-tradable commodity, are the least volatile in the Eastern Africa region. The unconditional standard deviation reports Irish potato price volatility to be in the range of 13% in Uganda to 28% in Ethiopia.

The finding that Eastern Africa maize prices are more volatile than the global maize markets is consistent with the finding of Mitchell (2008) who attributes most of the volatility in commodity prices to macro-economic and political instability. Over the study period, Ethiopia and Kenya experienced drought that necessitated massive importation of grain, draining foreign exchange reserves and destabilizing the countries' macro-economic status. In addition, Kenya and Tanzania imposed maize export bans that restricted supply. In 2008 Kenya experienced some political conflict in the form of post-election violence. The effect of the conflict was a restriction in supply that caused an imbalance in Kenya's macro-economic factors.

These persistently high food prices indicate a poor degree of price transmission from international markets to domestic markets in Kenya. The elasticities of price transmission for wheat prices in Ethiopia and Kenya were about 0.11 and 0.25 respectively. These estimates imply that 11% of the changes in international wheat prices are transmitted to markets in Ethiopia while 25% of the changes are transmitted to Kenya. Similarly, the speed of adjustment of domestic prices to the long-run relationship was 0.05 and 0.45 in Ethiopia and Kenya respectively. This implies that domestic wheat prices in Ethiopia take about 20 months to fully adjust to changes in world prices while they take about 2 months to fully adjust in Kenya.

In response to the volatility of staple commodities, the Kenya Government adopted several market and supply side policy options to cope with the persistent volatility. These included price support through NCPB, buffer stockholding, input subsidy programmes, export bans, duty free importation and design of irrigation schemes, the economic stimulus programme and physical infrastructure work. Other trade policies that were adopted included reducing import tariffs and taxes on maize and wheat. In June 2008 import duty on wheat was reduced by 25% (from 35% to 10%); that of maize was zero-rated after the Ministry of Agriculture intervened. Other fiscal measures included zero-rating value-added on wheat and maize flour, and milk. Despite these efforts, the price of maize continued to rise and by October/November 2008, the government shifted its strategy to direct protection of consumers through food subsides. This decision came after near food riots in Nairobi.

Given the persistent commodity price volatility in Kenya, this study recommends several policy options to deal with price volatility. These are supply response stimulating programmes such as governments buying surplus as buffer stock at competitive prices; input subsidy programmes; food-for-work programmes targeted to the poor working in agriculture; and establishment of market information systems to avail better information about prices and stock levels. In addition, the fact that international prices are far less volatile than domestic Eastern Africa food prices suggests that trade could play a useful role in stabilizing food prices.

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