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Food price volatility in sub-Saharan Africa: Has it really increased?

Nicholas Minot *

Markets, Trade, and Institutions Division, International Food Policy Research Institute, 2033 K Street NW, Washington, DC 20006, USA

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ABSTRACT

The food price crisis of 2007–2008 and recent resurgence of food prices have focused increasing attention on the causes and consequences of food price volatility in international food markets and the developing world, particularly in sub-Saharan Africa. In this paper, we examine the patterns and trends in food price volatility using an unusually rich database of African staple food prices. We find that international grain prices have become more volatile in recent years (2007–2010) but no evidence that food price volatility has increased in the region. This contrasts with the widespread view that food prices have become more volatile in the region since the global food crisis of 2007–2008. In addition, the results suggest that price volatility is lower for processed and tradable food than for nontradable food, that volatility is lower in the major cities than in secondary cities, and that maize price volatility is actually higher in countries with the most active intervention to stabilize maize prices. These findings suggest that greater attention should be given to the (high) level of food prices in the region rather than volatility per se, that regional and international trade can play a useful role in reducing food price volatility, and that traditional food price stabilization efforts may be counterproductive.

Introduction

Background

As a result of the global food crisis of 2007–2008 and the resurgence of food prices in 2010, there is unprecedented interest in high and volatile food prices. *The 2011 State of Food Insecurity in the World*, jointly published by the Food and Agriculture Organization (FAO), the International Fund for Agricultural Development, and the World Food Programme, concentrates on the impact of volatile food prices on food security in developing countries (FAO et al., 2011a,b). *Agricultural Outlook 2010–2011*, produced by the Organization for Economic Cooperation and Development (OECD) and the FAO, also focuses on the issue of food price volatility (OECD and FAO, 2011). The 2011 *Global Hunger Index*, prepared by the International Food Policy Research Institute (IFPRI) adopts food price volatility as the special theme for 2011 (IFPRI, 2011). In October 2010, the United National Committee on World Food Security commissioned a study of food price volatility, which resulted in a report published in October 2011 (HLPE, 2011). And in June 2011, the ministers of agriculture of the G20 countries prepared an action plan to address food price volatility (G20, 2011).

The reasons for the interest in the topic are clear. Instability in the price of staple foods is an important source of risk in developing countries. This is particularly true for poor households in sub-Saharan Africa. Three factors contribute to the strong link between food price volatility and risk for poor African households. First, the variation in staple food prices tends to be higher in Africa than in other regions (Minot, 2011). Second, poor households allocate a large share, often more than 60%, of their budgets to food, so a given variability in food prices has a large effect on purchasing power (FAO et al., 2011a,b, 14). Third, the share of the population that depends on agriculture for its livelihood is generally larger in Africa than in other regions. Within rural areas, semi-subsistence farmers are partially insulated from the effect of fluctuations in staple food prices, while cash-crop farmers, commercial grain producers, wage laborers, and those with nonfarm enterprises are more vulnerable (Benson et al., 2008).

Although food prices have increased substantially since 2006, the evidence of food price volatility is mixed. Gilbert and Morgan (2010) examine long-term trends in international food prices and find that volatility has been lower since 1990 than during the 1970–1989 period. They also test the difference in volatility between the 2007–2009 period and previous years. Of the 19 commodities tested, only 3 showed a statistically significant increase in price volatility (soybeans, soybean oil, and groundnut oil).

The OECD and FAO (2011) report states that there is no long-term trends toward increased volatility but notes that the "implied

* Tel.: +1 202 862 5691.
E-mail address: n.minot@cgiar.org

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volatility" associated with futures prices of wheat, maize, and soybeans has been rising steadily since 1990.[1] FAO et al. (2011a,b, 8) note that there is little or no evidence of a long-term increase in the volatility of international food prices but argue that "there is no doubt that the period since 2006 has been one of extraordinary volatility."

However, volatility in international prices affects households and businesses only to the extent that it is transmitted to domestic markets. It is almost universally accepted that food prices in Africa have become more volatile in recent years (see Gerard et al., 2011 and G20, 2011). However, few if any empirical studies have examined the trends and patterns in food price volatility in the region using recent data. FAO et al. (2011, 22) provide a graph showing that the average volatility of the prices of wheat, maize, and rice rose in 2008 before falling again in 2009; however, their report does not test the statistical significance of the change, nor does it report estimates of volatility before 2007.

The issue of changes in food price volatility has important implications for policy. The trends in food prices since 2007 have revived interest in regulating food markets in SSA. As Gerard et al. (2010, 11) note that "after the food crisis in 2008, the need for market regulation and the necessity of fighting price instability have been accepted by a growing percentage of experts and decision-makers."

A number of countries are increasing the size of their food reserves, and the topic of international food reserves is again under discussion (Murphy, 2009; von Braun and Torero, 2009). Gerard et al. (2011) argues that the high and volatile prices of food strengthen the case for government intervention to stabilize food prices in developing countries, in spite of the practical difficulties of doing so.

Objectives

The goal of this paper is to examine the patterns and trends in food price volatility in Africa. In particular, we are interested in testing the widely held belief that food prices have become more volatile since the global food crisis of 2007–2008.

The remainder of paper is organized as follows: Section 2 describes the definition and measurement of food price volatility, the data used in this analysis, and the method for statistically testing differences in volatility. Section 3 provides the results of the analysis. To provide some context, we first examine volatility in international grain prices. Then the patterns and trends in food price volatility in Africa are explored, including changes in volatility in recent years. Finally, Section 4 summarizes the results and discusses their implications.

Data and methods

Defining and measuring food price instability

Food price instability refers to variation over time in the price of food. In this report, we focus primarily on instability in the price of maize, rice, wheat, and other staple foods in Africa. Although cassava and other root crops are important staples in many countries in the region, these cannot be stored long after harvest and, for this reason, are not the focus of government efforts to stabilize food prices. Cassava does play an important role in helping households adapt to grain price instability (Dorosh et al., 2009; Prudencio and Al-Hassan, 1994).

Variation is sometimes measured using the coefficient of variation (CV), defined as CV = s/μ, where s is the standard deviation of the variable of interest over a given time period and μ is the mean value over that period. However, this measure has a disadvantage when used to measure price instability. Prices are often non-stationary, exhibiting a unit-root or random-walk behavior. Under these conditions, the variance and standard deviation approach infinity as the time period approaches infinity. In practical terms, this means that the estimate of variability depends on the length of time covered by the sample.

Another measure of variability, often used in financial market analysis, is the standard deviation of returns, where the return is defined as the proportional change in price from one period to the next. The return is generally measured as the difference in the logarithm of prices from one period to the next. This concept, called unconditional volatility, can be expressed as follows:

$$\text{Unconditional volatility} = \text{stdev}(r)\left[\sum \frac{1}{N-1}(r_t - \bar{r})^2\right]^{0.5} \qquad (1)$$

where

$$r_t = \ln(p_t) - \ln(p_{t-1})$$

$$\bar{r} = \sum \frac{1}{N} r_t$$

If prices follow a unit-root process with a multiplicative error term, then r will be stationary and its standard deviation will not depend on the size of the sample. This concept is unconditional in that it does not take into account any prior information and is based only on observed variation in returns.

An alternative approach is to test the conditional variance of returns using a generalized autoregressive conditional heteroskedasticity (GARCH) model (Engle, 1982; Bollerslev, 1986). A GARCH(p,q) model can be expressed as follows:

$$r_t = \mu + \varepsilon_t$$

$$var(\varepsilon_t) = \sigma_t^2 = \gamma + \sum\nolimits_{i=1}^{q} \alpha_{ie_{t-i}}^2 + \sum\nolimits_{j=1}^{p} \beta_j \sigma_{t-j}^2$$

The GARCH model has the advantage of allowing the variance of returns (and hence volatility) to change over time as a function of lagged squared residuals (e_{t-i}^2) and lagged variance (σ_{t-j}^2). Conditional volatility is the estimated value of σ_t. This approach has been used by Gilbert and Morgan (2010) and others to study changes in (conditional) volatility in food prices.

Volatility in food prices can be measured at the producer, wholesale, or retail level. In Africa, most data on food prices are at the wholesale or retail level. If margins between producer, wholesale, and retail prices are a constant proportion of the price, then measuring the volatility at any of the three levels will give the same result. However, if margins are fixed, then producer prices will be the most volatile and retail prices the least, with the volatility of wholesale prices falling in between. In practice, however, other factors influence the marketing margins such as the degree of competition at each level in the channel, the availability of information, changes in road quality or congestion, and the volume of trade between markets. Instability can also be measured at different time scales, using daily, monthly, or annual price data.

Data sources

This analysis uses data on international grain prices and on staple food prices in Africa. Data on international grain prices were obtained from the International Monetary Fund (IMF). In particular, we use the prices of maize (No. 2 yellow maize free-on-board (FOB) Gulf of Mexico), rice (5% broken milled white rice FOB Bangkok), and wheat (No. 1 hard red winter wheat, ordinary protein, FOB Gulf of Mexico) from the IMF database (IMF, 2011).

[1] Implied volatility is derived from the futures market price of a commodity, the risk-free interest rate, and a theoretical model of how asset prices should be formed in the face of price volatility. As such, it is different from the actual volatility of the price.

The data are monthly and cover the period January 1980 to March 2011.

This analysis of food prices in Africa makes use of monthly prices of staple foods compiled by the Famine Early Warning System Network (FEWS-NET), a project funded by the United States Agency for International Development (USAID). FEWS-NET collects some prices, but most of their price data are gathered from statistical agencies in the countries where it operates (see FEWS-NET, 2011a).

The analysis focuses on 10 staple foods: beans, bread, cooking oil, cowpeas, maize, millet, rice, sorghum, teff, and wheat. Bread and cooking oil were included to explore whether the volatility of prices of processed foods differs from that of staple crops.

Price data invariably contains some missing values, so it is necessary to establish criteria in selecting price series to analyze. For the analysis of the patterns of volatility, we select price series that contain at least 90% of the observations between January 2005 and March 2011. This results in 167 price series from 15 countries: Chad, Ethiopia, Guinea, Kenya, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, Tanzania, Uganda, Zambia, and Zimbabwe. The bulk of the price series are at the retail level, though 12% are wholesale prices and 6% are assembly-level prices.

For the analysis of changes in volatility, it is useful to have a somewhat longer time series. Thus, we limit ourselves to those prices that include at least 90% of the observations between January 2003 and December 2010. This leaves 67 price series from 11 countries: Chad, Kenya, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Tanzania, Uganda, and Zambia. This dataset includes prices for six staple foods: beans, cooking oil, maize, millet, rice, and sorghum.

Analysis

To evaluate changes in unconditional price volatility, we test the null hypothesis that the two sets of prices have the same standard deviation in returns and use the *F*-statistic to test the probability that the null hypothesis is true, using a 5% confidence threshold. In examining the patterns of price volatility across markets and commodities, we are often comparing two sets of price series. The returns (r) are normalized by expressing them as deviations from the mean return for each commodity. In this way, the standard deviation of returns for a set of prices does not include any cross-price differences in the mean return.[2] The test is implemented using the "sdtest" command in Stata.

In order to check the robustness of the results, we also test changes in conditional price volatility. Because we are examining over one hundred price series, it is convenient to apply the same model to all series. We use the GARCH(1,1) model to estimate the conditional volatility in food prices, since it has been shown to perform well against alternative specifications (Hansen and Lunde, 2001). In the interest of space and because the unconditional and conditional volatility results are quite similar, the discussion focuses on the test of unconditional volatility, but also describes any discrepancies between the two measures. The tests of conditional volatility are presented in the annex.

Results

Volatility in international grain prices

To provide some context for interpreting the patterns and trends in food price volatility in Africa, we begin by examining grain price volatility in international markets. As described above, volatility is defined as the standard deviation of returns to commodity prices, where the return is the difference in the logarithm of prices from one month to the next. The first panel of Table 1 compares unconditional price volatility during 1980–2006 with that during 2007–2010. The volatility of international rice and wheat prices roughly doubled, as did the volatility of the International Monetary Fund (IMF) food price index. The volatility of international maize prices increased by more than 50%. All of these increases are statistically significant at the 1% level.

The second panel of Table 1 compares price volatility during 2003–2006 with volatility during 2007–2010. This comparison is provided because these are the two periods we use later to examine staple food prices in Africa. As before, the increases in volatility of all three international prices and the IMF food price index are statistically significant. The volatility of the international price of rice more than tripled, rising from 0.030 during 2003–2006 to 0.101 during 2007–2010. Analysis of the conditional volatility of international grain prices reveals a similar pattern except that the increase in volatility for maize prices is not statistically significant (see Table A1 in the annex). These findings confirm the conventional wisdom regarding increasing volatility in international markets for food grains.

Distribution of food price volatility in sub-Saharan Africa

The analysis of the cross-sectional patterns in staple food price volatility in Africa is based on a database of 167 monthly price series, each of which covers the period January 2005 to March 2011. The average volatility (standard deviation of returns) is 0.116 and the median is 0.109 (see Fig. 1). One-quarter of the volatility measures are below 0.085 and three-quarters are below 0.141. The highest volatility (0.46) was the retail price of maize in Harare, expressed in US dollars, which is not surprising given the economic and political turmoil in the country during this period. The analysis of conditional volatility is limited to 113 of these price series. For about one-third of the prices, the GARCH estimation did not achieve convergence. This is not surprising given that the log-likelihood function of the GARCH model is not always well behaved and achieving a global maximum is sometimes difficult (Zivot, 2009).

We can compare the volatility in African markets with the volatility for the same commodities on the international market. Using the IMF monthly price data, the unconditional volatility of maize on international markets during this same time period is 0.073, while that of both rice and wheat is 0.082. Of the 47 maize prices for which we have information from Africa, 46 are more volatile than the international price of maize. Of the 21 rice prices from Africa, 13 are more volatile than international price of rice. And two of the three African wheat prices are more volatile than the international price of wheat. Overall, 61 out of 71 African prices

Table 1
Unconditional volatility in international grain prices. *Source:* Analysis of price data from IMF (2011) covering the period January 1980 to December 2010.

	N	1980–06	2007–10	*F* stat	*p*
Maize	371	0.054	0.082	0.44	0.00
Rice	371	0.054	0.101	0.29	0.00
Wheat	371	0.048	0.097	0.24	0.00
IMF food index	239	0.024	0.044	0.28	0.00
	N	2003–06	2007–10	*F* stat	*p*
Maize	96	0.054	0.082	0.44	0.01
Rice	96	0.030	0.101	0.09	0.00
Wheat	96	0.048	0.097	0.24	0.00
IMF food index	96	0.026	0.044	0.34	0.00

[2] Normalized r is calculated as the deviation from the mean value of r for the price series. Since the mean value of r is usually close to zero, the adjustment is minor. Even if the mean value were large, normalizing r does not affect the standard deviation and hence the calculation of volatility for an individual price series.

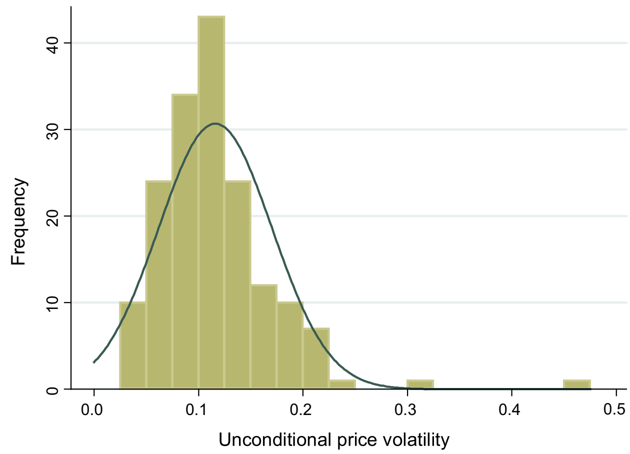

Fig. 1. Distribution of unconditional volatility across 167 African staple food prices. *Source*: Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

for these three commodities are more volatile than the corresponding international price.

To provide a visual illustration of the range of volatility, Fig. 2 shows the retail price of millet in Timbuktu (Mali). The unconditional volatility of this price during 2005–2011 is 0.058, placing it at the 10th percentile in volatility, making it among the most stable prices among those under consideration. Figs. 3 and 4 show the returns to the millet price and a 13-month moving average of volatility, respectively. In contrast, the retail price of rice in Nampula (Mozambique) has a volatility measure of 0.186, putting it at the 90th percentile in volatility. Figs. 5–7 show the retail price, returns, and the moving average volatility for rice in Nampula.

Price volatility for different commodities

How does price volatility vary across commodities? Table 2 shows the price volatility between January 2005 and March 2011 for each product where data are available, as well as the results of a test of the statistical significance of the difference between the price volatility of the commodity and the volatility of the other commodities on the list.

According to the table, unconditional price volatility is lowest for bread (0.028), wheat (0.094), and cooking oil (0.101). The

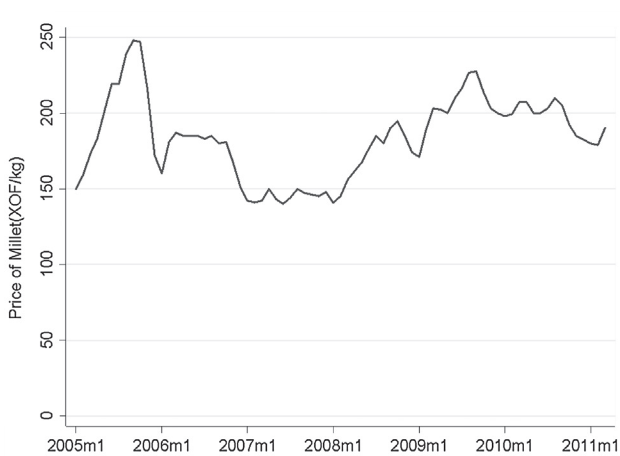

Fig. 2. Retail price of millet in Timbuktu (Mali). *Source*: Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

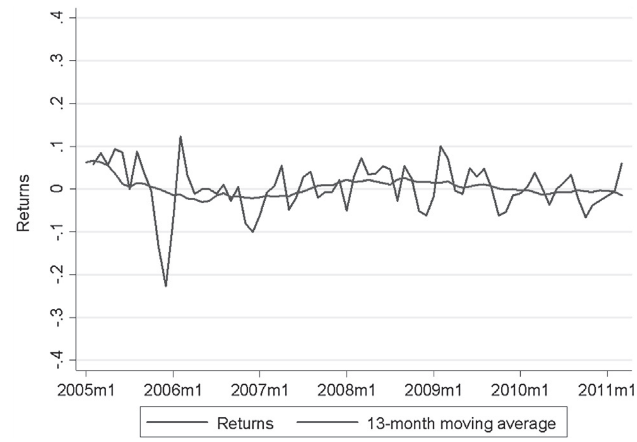

Fig. 3. Returns to millet in Timbuktu. *Source*: Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

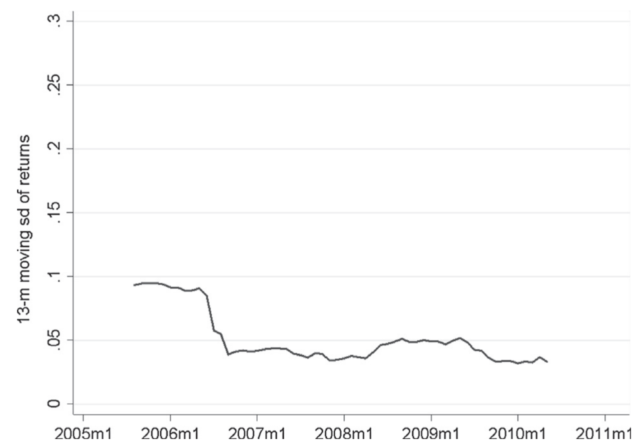

Fig. 4. Volatility of the millet price in Timbuktu. *Source*: Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

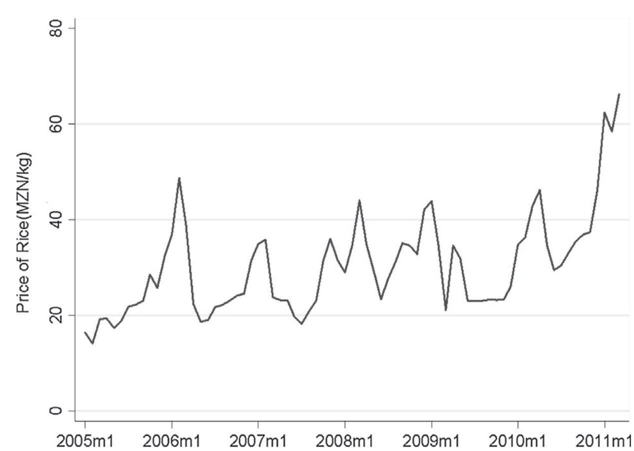

Fig. 5. Retail price of rice in Nampula (Mozambique). *Source*: Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

analysis of conditional price volatility reveals a similar pattern: these are three of the four least volatile commodities (see Table A2 in the annex). It is interesting to note that the processed foods are among those with the most stable prices. This may be related to the fact that the raw material accounts for a relatively small share of the total costs and that other components of

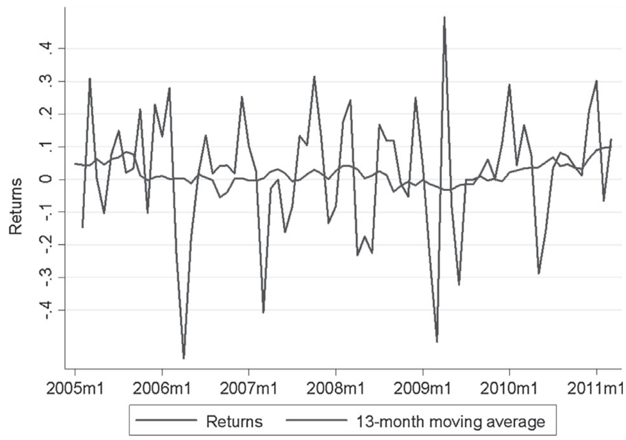

Fig. 6. Returns to rice in Nampula. *Source*: Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

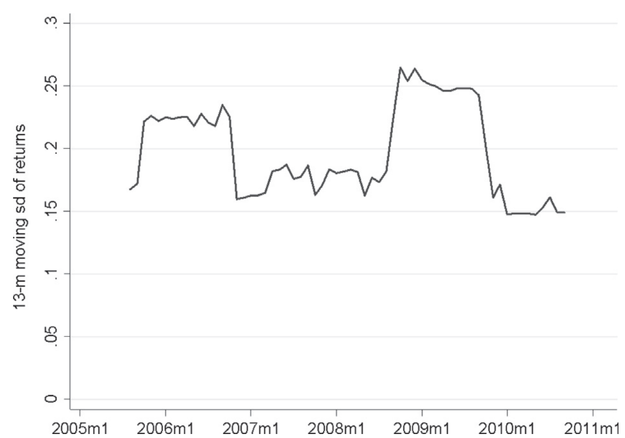

Fig. 7. Volatility of the price of rice in Nampula. *Source*: Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

food-processing costs (for example, labor, equipment, and electricity) may have more stable prices. However, any interpretation must be tentative given the small number of price series in the data: two for bread and eight for cooking oil.

The prices of teff, millet, and rice are also less volatile than the average, whether measured as unconditional volatility (Table 2) or conditional volatility (Table 13). The relatively low price volatility for millet and teff is probably related to the fact that they are drought-tolerant crops. Teff is grown almost exclusively in the highlands of Ethiopia, while millet is grown in semiarid zones, particularly in West Africa. The relatively stable price of rice may be associated with the fact that it is a tradable commodity in most countries in the region. As discussed above, in spite of recent increases in volatility in world markets, world grain prices remain more stable than African grain prices.

Table 2
Unconditional price volatility across products. *Source:* Analysis based on price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

	Nbr of obs	Nbr of prices	Volatility	*F* stat	*p*
Beans	878	12	0.133	0.905	0.04
Bread	149	2	0.028	21.378	0.00
Cooking oil	592	8	0.101	1.588	0.00
Cowpeas	369	5	0.230	0.283	0.00
Maize	3450	47	0.144	0.693	0.00
Millet	2224	30	0.105	1.544	0.00
Rice	2202	30	0.108	1.448	0.00
Sorghum	1914	26	0.124	1.044	0.22
Teff	296	4	0.104	1.495	0.00
Wheat	224	3	0.094	1.848	0.00
Total	12,298	167	0.127	0.000	0.00

It is interesting to note that many of the products with relatively stable prices (rice, wheat, and cooking oil) are tradable products. Imports account for a large share of the supply of wheat (70%), rice (43%), and cooking oil (49%) in Africa (FAO, 2010). In contrast, the four products with the highest price volatility (cowpeas, maize, beans, and sorghum) are generally considered nontradable. Although there is regional trade in all these staple crops, international trade in these commodities is quite small relative to the volume of domestic production and consumption. According to the FAO (2010), imports account for just 8 percent of African maize supply, 2% of sorghum supply, and 5% of the supply of pulses.

Table 3 provides a test of the unconditional price volatility in tradable goods (rice, wheat, and cooking oil) compared with that of the other commodities. The price volatility of tradables is 0.106, while that of nontradables is 0.133, a difference that is statistically significant at the 1% level. The conditional price volatility of tradables is also significantly higher than that of nontradables (see Table A3).

The prices of tradable commodities are largely determined by international markets, although fluctuations in the exchange rate and trade policy also play a role. In contrast, volatility in the price of nontradable commodities is determined primarily by domestic supply-and-demand conditions, particularly weather-related fluctuations in supply. These findings challenge the idea that instability in international markets is the main source of price volatility in Africa and suggest that domestic factors play a larger role in price volatility. This finding raises questions about the widespread view that self-sufficiency in staple food crops would reduce food price volatility.

Price volatility across markets

This section considers the variation in price volatility across markets. In particular, we focus on the volatility in maize prices across countries, differences between coastal and landlocked countries, and differences in price volatility between the largest cities and the smaller markets.

Maize price volatility across countries

In comparing price volatility across countries, it is convenient to focus on maize for two reasons. First, the database contains a large number of maize price series (47), ensuring at least a few prices in each country. Second, maize is the most important source of calories in many African countries, particularly in eastern and southern Africa (FAO, 2010). For this reason, the volatility in the price of maize is more politically important than volatility in the price of other food commodities.

Table 4 shows the unconditional volatility in maize prices in 11 countries, along with a statistical test of whether there is a statistically significant difference between volatility in that country and

Table 3
Unconditional price volatility of tradable and nontradable products. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

	Nbr of obs	Nbr of prices	Volatility	*F* stat	*p*
Non-tradables	9280	126	0.133	0.000	0.00
Tradable products	3018	41	0.106	1.570	0.00
Total	12,525	167	0.127	0.000	0.00

volatility in the other countries. The highest unconditional price volatility is found in Zimbabwe (0.462), followed by Malawi (0.197), Zambia (0.137), and Chad (1.32). The conditional volatility of maize prices follows a similar pattern, except that the GARCH model does not converge for Zimbabwe maize prices (see Table A4).

The extremely high volatility in maize prices in Zimbabwe is probably attributable to the political and economic turmoil that the country has experienced for the last 10–15 years. The confiscation and reallocation of large-scale commercial farms has disrupted maize production, while hyperinflation and occasional disturbances have discouraged investment. In addition, in 2002 the government of Zimbabwe gave the Grain Marketing Board (GMB), a state trading enterprise, a virtual monopoly on maize trade (it remained legal for farmers to market quantities up to 150 kg). These policies continued until market reforms were introduced in 2010 (Takavarasha, 2006; Madera, 2011).

In Malawi, the Agricultural Development and Marketing Corporation (ADMARC) has played an important role in maize marketing and trade. Its role has included serving remote areas, stabilizing prices, and mobilizing surpluses for export. Although its purchases and sales were declining in the years leading up to the global food crisis, it was given expanded powers and resources in the wake of the crisis (Chirwa, 2009).

In Zambia, the government created the Food Reserve Agency (FRA) in 1995 to manage food security stocks. Purchases remained a small share of annual production (0–9%) for the first 10 years of its existence. In 2005, the FRA was given a larger mandate and budget, allowing it to open 600 buying station and to expand maize procurement to about 25% of total production. The pan-territorial procurement price is often above the local wholesale price, providing a significant advantage to those able to sell to the FRA. Imports and exports of maize and wheat require permits that specify the quantity to be traded. In recent years, most of the permits have been issued to the FRA. Thus, the FRA has come to play a dominant role in both domestic maize marketing and international grain trade (Dorosh et al., 2009).

In Kenya, the National Cereals and Produce Board (NCPB) buys and sells maize and other commodities in an effort to stabilize prices. In the 1980s, the NCPB maintained a monopoly on domestic and international trade in maize. In the early 1990s, reforms were implemented to eliminate internal movement restrictions and maize price controls. As a result of increased competition with the private sector, the closure of many buying stations, and budget cuts, the NCPB's share of the maize marketing fell to 10–20% in the second half of the 1990s. However, since 2005, under pressure from large-scale commercial farmers and possibly in response to the election cycle, the government began to increase funding to NCPB, allowing it to purchase 25–35% of the marketed volume in a good-harvest year or 10–15% of production (Ariga and Jayne, 2010).

Table 4
Unconditional volatility in maize prices by country. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

	Nbr of obs	Nbr of prices	Volatility	*F* stat	*p*
Chad	223	3	0.132	1.20	0.07
Ethiopia	294	4	0.095	2.38	0.00
Kenya	597	8	0.117	1.62	0.00
Malawi	364	5	0.197	0.48	0.00
Mozambique	523	7	0.114	1.69	0.00
Niger	364	5	0.113	1.69	0.00
Nigeria	224	3	0.125	1.35	0.00
Tanzania	149	2	0.110	1.74	0.00
Uganda	73	1	0.092	2.47	0.00
Zambia	570	8	0.137	1.13	0.08
Zimbabwe	69	1	0.462	0.08	0.00
Total	3525	47	0.144		

The Ethiopia Grain Trading Enterprise is involved in buying and selling grain on behalf of the government, but its operations are quite small relative to the size of the grain market. Similarly, Tanzania has maintained small emergency food reserves but does not actively attempt to stabilize prices. Uganda and Mozambique have no state marketing board responsible for maize marketing, nor do they maintain food reserves.

We can divide the countries roughly into two groups: those with state marketing boards that maintain reserves and attempt to stabilize prices, and those that do not intervene as actively in maize markets. Kenya, Malawi, Zambia, and Zimbabwe can be classified *high-intervention* countries, while the others are classified as *low-intervention* countries. As shown in Table 5, maize price volatility is more than 50% higher in countries where the government intervenes more actively in maize markets (0.172) than in countries with relatively little intervention (0.113), a difference that is statistically significant at the 1% level. This pattern holds even if we exclude Zimbabwe from the analysis. The difference is also statistically significant in the analysis of conditional price volatility (see Table A5).

These results can be interpreted in at least two ways. It is possible that maize price volatility would be even higher in the countries with more active intervention policies. Perhaps the intervention policies are a response to intrinsically more volatile prices in those countries.

Another interpretation is that the efforts to stabilize prices and manage maize markets are counterproductive. The uncertainty created by government intervention in maize markets can cause private traders to withdraw from the market, reducing the effect of temporal arbitrage in smoothing prices over time. Indeed, a number of researchers have suggested that active intervention by the government in food markets, particularly when it involves price controls or unpredictable purchases and sales, discourages private traders from storage or trade in staple foodgrains. Unless fully offset by public-sector grain-trading activity, this would exacerbate seasonal price volatility, regional price differences, and price spikes during low-harvest years (Chirwa, 2009; Chapoto and Jayne, 2009; Byerlee et al., 2006).

Coastal versus landlocked

We expect that access to wider markets will reduce price volatility. Based on this idea, we divide the markets into those that are in a country with a coast and those that are in a landlocked country. For each commodity, we test the statistical significance of differences in the volatility between these two groups. The results are shown in Table 6. Beans, bread, cooking oil, and cowpeas show no significant difference in price volatility between coastal and landlocked countries. Furthermore, the prices of millet, rice, sorghum, and wheat are significantly *less* volatile in landlocked countries. Only in the case of maize is price volatility higher in landlocked countries (0.161) than in coastal countries (0.116), a difference that is statistically significant. Similar patterns are observed in conditional price volatility (see Table A6).

Table 5
Unconditional maize price volatility by level of intervention in maize markets. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

	Nbr of obs	Nbr of prices	Volatility	*F* stat	*p*
Low	1850	25	0.113		
High	1600	22	0.172		
Total	3450	47	0.144	0.43	0.00

Note: Kenya, Malawi, Zambia are classified as having a high level of intervention, while other countries fall in the low category.

Table 6
Unconditional price volatility in coastal and landlocked countries by product. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

Nbr obs	Nbr prices	Coastal	Landlocked	*F* stat	*p*
878	12	0.134	0.121	1.23	0.28
149	2	0.029	0.027	1.14	0.56
592	8	0.105	0.098	1.16	0.20
369	5	0.246	0.218	1.27	0.10
3450	47	0.116	0.161	0.52	0.00
2224	30	0.125	0.100	1.55	0.00
2202	30	0.141	0.084	2.82	0.00
1914	26	0.144	0.115	1.56	0.00
224	3	0.122	0.076	2.60	0.00

Table 7
Unconditional price volatility in the largest city and other cities by product. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2005 to March 2011.

	Nbr obs	Nbr prices	Largest city	Other cities	*F* stat	*p*
Beans	878	12	0.098	0.142	0.48	0.00
Cooking oil	592	8	0.070	0.125	0.32	0.00
Maize	3450	47	0.098	0.151	0.42	0.00
Millet	2224	30	0.103	0.106	0.96	0.68
Rice	2202	30	0.071	0.116	0.38	0.00
Sorghum	1914	26	0.116	0.126	0.84	0.04
Teff	296	4	0.064	0.115	0.32	0.00
Wheat	224	3	0.095	0.092	1.07	0.75
Total	12,298	160	0.091	0.134	0.45	0.00

It is not easy to interpret these results. One possibility is that whether a country has a coast or not is only a rough measure of the access that traders in the country have to international markets. For example, the Kagera region in western Tanzania (a coastal country) has less access to international markets than Kampala, even though Uganda is a landlocked country.

Large city versus smaller city

Another way to group markets is by the size of the city. In each country, we identify the largest city, which is typically the capital city. For each commodity, the difference in price volatility between the largest city and other cities is compared and tested statistically. As shown in Table 7, unconditional price volatility is lower in the largest city than in other cities for six commodities: beans, cooking oil, maize, rice, sorghum, and teff. Only millet and wheat do not show any statistically significant difference. Similar results are obtained from the analysis of conditional price volatility, except that the difference in volatility in the price of cooking oil is not statistically significant and wheat price volatility is higher in the largest cities (see Table A7).

The most likely explanation is that the largest city draws surplus food from various parts of the country. Assuming some variation in agroecological conditions, this allows supplies to come during different months of the year, thus smoothing prices over the year. In contrast, a smaller city may be more affected by the local harvest cycle and less able to draw supplies from larger markets when needed. In addition, a large city is likely to be characterized by better storage infrastructure and more competitive markets, which could help stabilize prices.

Changes in price volatility over time

In this section, we test the widely-held perception that food prices in domestic African markets have become more volatile since the global food crisis of 2007–2008. To measure changes in volatility over time, we limit ourselves to prices series that cover the period January 2003 to December 2010, allowing no more than 10% of the observations during this period to be missing. These tighter criteria reduce the number of price series available for analysis to 67. For each price series, we compare the level of volatility during two four-year periods: 2003–2006 and 2007–2010. The reason for splitting the sample in this way is that the global food crisis began with the increase in commodity prices during 2007. Most international prices peaked in mid-2008, before declining partially 2009, only to rise again in 2010.

Table 8 shows the level of unconditional volatility during these two periods for each of the 67 food prices under consideration. The results confirm that some prices did become more volatile in the 2007–2010 period, including maize prices in two markets in Kenya, maize prices in three markets in Mozambique, and rice prices in one market in Chad. However, only 7 of the 67 prices tested showed a statistically significant increase in volatility between 2003–2006 and 2007–2010. Furthermore, 17 prices show a statistically significant decrease in volatility between these two periods. For example, price volatility fell for maize in Maputo, rice in N'Djamena, and sorghum in Nouakchott. The remaining 43 prices tested did not show any statistically significant change in volatility between 2003–2006 and 2007–2010. In the analysis of conditional volatility, 19 of the price series could not be analyzed due to non-convergence in the GARCH estimation. Of the 48 remaining prices, only two showed a change in volatility that was significant at the 5% level and in both cases price volatility declined (these results are available upon request).

It could be argued that the number of observations for each price series (96 months) is not sufficient to test changes in volatility. Two pieces of evidence suggest that this is not the explanation. First, if volatility rose between the two periods but the sample size was too small to find statistically significant differences, we would expect the volatility to increase in most of the price series even if the change was not significant. In fact, unconditional volatility declined in 50 of the prices and increased in only 17 (see Table 8).

Second, we can increase the sample size by aggregating the data to the product level or by aggregating all 67 price series together. Table 9 shows the aggregated results for each of the six products and then aggregated across all products. Unconditional price volatility of maize increased significantly between 2003–2006 and 2007–2010, but price volatility of beans, millet, and rice declined. No statistically significant change in price volatility occurred with cooking oil and sorghum. Across all commodities, volatility declined by a relatively small but statistically significant margin.

These results confirm the conventional wisdom that maize prices have become more volatile since 2007 (although the increase in volatility was just 7%). But the results also support the surprising finding from Table 8 that the volatility of staple food prices in general either has not increased (cooking oil and sorghum) or has actually decreased (beans, millet, and rice). Similarly, in the case of conditional price volatility, rice and millet volatility declined, while the other commodities show no statistically significant change (see Table A8).

Another attempt to reconcile the widespread view that African food price volatility increased in the wake of the global food crisis and the lack of empirical evidence of this is to revise the time period. Perhaps the increase in price volatility did not last four years (2007–2010) but rather occurred just in 2008, the year that prices peaked during the global food crisis. Table 10 shows the test results of whether the price volatility was higher in 2008 than during the rest of the period 2003–2010. Surprisingly, none of the prices tested showed a statistically significant increase in volatility, and three of the six show a significant *decrease* in volatility in 2008. With regard to conditional volatility, none of the commodities show a significant change in volatility in 2008 (see Table A9).

Table 8
Change in unconditional volatility of staple food prices in Africa between 2003–2006 and 2007–2010. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2003 to December 2010.

Commodity	Country	Market	Level	*N*	Volatility		*F* stat	*p*
					2003–06	2007–10		
Beans	Kenya	Nairobi	Wholesale	99	0.089	0.078	1.31	0.35
Beans	Mozambique	Chokwe	Retail	99	0.201	0.194	1.08	0.80
Beans	Mozambique	Gargongosa	Retail	99	0.155	0.118	1.74	0.06
Beans	Mozambique	Manica	Retail	97	0.221	0.132	2.80	0.00
Beans	Mozambique	Maputo	Retail	99	0.084	0.089	0.89	0.67
Beans	Mozambique	Maxixe	Retail	99	0.164	0.138	1.42	0.23
Beans	Mozambique	Nampula	Retail	98	0.064	0.048	1.76	0.05
Beans	Rwanda	Kigali	Retail	91	0.113	0.121	0.88	0.68
Cooking oil	Mozambique	Maputo	Retail	97	0.065	0.064	1.05	0.86
Cooking oil	Mozambique	Nampula	Retail	99	0.178	0.162	1.21	0.51
Maize	Chad	N'Djamena	Retail	99	0.116	0.098	1.39	0.26
Maize	Kenya	Eldoret	Wholesale	93	0.135	0.103	1.71	0.07
Maize	Kenya	Kisumu	Wholesale	99	0.099	0.100	0.97	0.91
Maize	Kenya	Kitui	Retail	98	0.109	0.251	0.19	0.00
Maize	Kenya	Lodwar	Retail	99	0.114	0.084	1.85	0.04
Maize	Kenya	Mandera	Retail	99	0.113	0.102	1.23	0.47
Maize	Kenya	Marsabit	Retail	99	0.061	0.099	0.38	0.00
Maize	Kenya	Nairobi	Wholesale	99	0.092	0.088	1.10	0.74
Maize	Malawi	Karonga	Retail	91	0.178	0.218	0.67	0.19
Maize	Mozambique	Chokwe	Retail	97	0.092	0.154	0.36	0.00
Maize	Mozambique	Gargongosa	Retail	99	0.077	0.130	0.35	0.00
Maize	Mozambique	Manica	Retail	99	0.179	0.159	1.28	0.40
Maize	Mozambique	Maputo	Retail	99	0.127	0.079	2.61	0.00
Maize	Mozambique	Maxixe	Retail	99	0.051	0.048	1.13	0.68
Maize	Mozambique	Nampula	Retail	99	0.093	0.093	1.02	0.96
Maize	Mozambique	Tete	Retail	99	0.071	0.114	0.39	0.00
Maize	Niger	Niamey	Retail	99	0.078	0.071	1.21	0.52
Maize	Tanzania	Dar es Sal.	Wholesale	99	0.129	0.106	1.47	0.18
Maize	Tanzania	Mbeya	Wholesale	94	0.132	0.106	1.55	0.14
Maize	Uganda	Kampala	Retail	97	0.121	0.094	1.65	0.09
Maize	Zambia	Kitwe	Retail	99	0.148	0.127	1.36	0.29
Maize	Zambia	Lusaka	Retail	99	0.119	0.102	1.35	0.30
Millet	Chad	Abeche	Retail	99	0.110	0.105	1.11	0.73
Millet	Chad	Moundou	Retail	99	0.155	0.098	2.49	0.00
Millet	Chad	Moussoro	Retail	99	0.122	0.100	1.49	0.17
Millet	Chad	N'Djamena	Retail	99	0.103	0.109	0.88	0.67
Millet	Chad	Sarh	Retail	99	0.159	0.105	2.29	0.00
Millet	Mali	Gao	Retail	99	0.087	0.060	2.13	0.01
Millet	Mali	Kayes	Retail	99	0.050	0.040	1.61	0.10
Millet	Mali	Koulikoro	Retail	99	0.114	0.048	5.55	0.00
Millet	Mali	Mopti	Retail	99	0.081	0.047	2.89	0.00
Millet	Mali	Segou	Retail	99	0.114	0.073	2.41	0.00
Millet	Mali	Sikasso	Retail	99	0.083	0.057	2.10	0.01
Millet	Mali	Timbuktu	Retail	97	0.079	0.041	3.67	0.00
Millet	Niger	Agadez	Retail	99	0.100	0.069	2.09	0.01
Millet	Niger	Diffa	Retail	97	0.103	0.093	1.23	0.49
Millet	Niger	Maradi	Wholesale	99	0.113	0.111	1.03	0.92
Millet	Niger	Niamey	Retail	99	0.085	0.082	1.07	0.83
Millet	Niger	Tahoua	Retail	99	0.125	0.107	1.37	0.28
Millet	Uganda	Soroti	Retail	97	0.105	0.084	1.57	0.12
Rice (local)	Chad	Mousoro	Retail	99	0.109	0.069	2.49	0.00
Rice (local)	Chad	N'Djamena	Retail	99	0.148	0.075	3.84	0.00
Rice (local)	Niger	Agadez	Retail	99	0.026	0.048	0.30	0.00
Rice	Mali	Segou	Retail	99	0.085	0.043	3.84	0.00
Rice	Mozambique	Manica	Retail	99	0.081	0.096	0.72	0.25
Rice	Mozambique	Maputo	Retail	99	0.056	0.053	1.15	0.63
Rice	Mozambique	Maxixe	Retail	90	0.097	0.093	1.09	0.77
Rice	Mozambique	Nampula	Retail	99	0.188	0.189	0.99	0.97
Rice	Mozambique	Tete	Retail	99	0.227	0.176	1.67	0.08
Sorghum	Chad	Abeche	Retail	97	0.078	0.114	0.46	0.01
Sorghum	Chad	Moundou	Retail	99	0.156	0.147	1.12	0.71
Sorghum	Chad	N'Djamena	Retail	99	0.137	0.113	1.48	0.18
Sorghum	Chad	Sarh	Retail	99	0.174	0.208	0.70	0.22
Sorghum	Mauritania	Nouakchott	Retail	92	0.254	0.156	2.66	0.00
Sorghum	Niger	Maradi	Retail	94	0.112	0.080	1.97	0.02
Sorghum	Niger	Tahoua	Retail	99	0.095	0.124	0.59	0.07
Sorghum	Uganda	Soroti	Retail	97	0.118	0.133	0.78	0.39

It is possible that volatility measured at a longer frequency would show an increase in price volatility, thus agreeing more closely with conventional wisdom. This analysis has calculated volatility as the standard deviation of *monthly* returns in prices, but volatility can be calculated at other frequencies. For example, suppose prices rose 10% per month for three months, then fell by the same proportion for three months. The monthly volatility of this series would be the same as six months alternating 10% increases

Table 9
Change in unconditional volatility in aggregated food prices in Africa between 2003–2006 and 2007–2010. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2003 to December 2010.

	Nbr obs	Nbr prices	Volatility		*F* stat	*p*
			2003–06	2007–10		
Beans	781	8	0.146	0.121	1.45	0.00
Cooking oil	196	2	0.135	0.122	1.21	0.35
Maize	2154	22	0.114	0.122	0.87	0.02
Millet	1776	18	0.107	0.082	1.68	0.00
Rice	882	9	0.127	0.106	1.46	0.00
Sorghum	776	8	0.148	0.138	1.15	0.17
Overall	6565	67	0.123	0.113	1.20	0.00

Table 10
Change in unconditional volatility in aggregated food products in Africa between 2003–2010 and 2008. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2003 to December 2010.

	Nbr obs	Nbr prices	2003–10	2008	*F* stat	*p*
Beans	781	8	0.137	0.109	1.58	0.01
Cooking oil	196	2	0.127	0.138	0.84	0.53
Maize	2154	22	0.117	0.123	0.91	0.27
Millet	1776	18	0.095	0.099	0.92	0.42
Rice	882	9	0.120	0.098	1.48	0.01
Sorghum	776	8	0.146	0.118	1.51	0.01
Overall	6565	67	0.118	0.112	1.12	0.03

and 10% decreases, yet the range of the latter series would be larger, as would the volatility measured in three-month intervals.

To test this hypothesis, we run the tests in Table 9 using volatility measured at two-, four-, and six-month intervals. To save space, we present only the volatility estimates in the two periods and the probability of the null hypothesis of no difference (full results are available from the author). The results are shown in Table 11.

The results indicate that the trends in volatility are not sensitive to changes in the frequency at which it is measured. More specifically, if volatility is measured at two- four-, and six-month intervals, the prevailing pattern is a decline in food price volatility between the period 2003–2006 and the period 2007–2010. The reduction in volatility is statistically significant at the 1% level in 14 of the 18 product-period combinations and in all three of the overall food-price volatility estimates. Maize prices are again the main exception. The volatility in maize prices at two- and four-month intervals shows no statistically significant change between the two periods, while the volatility of maize prices at six-month intervals increases significantly between the two periods.

Finally, it is possible that food price volatility has changed, but not in a way that can be captured by the dummy variables we have selected. Fig. 8 shows the distribution of price volatility over the 67 food prices being examined and over time. Volatility is calculated as the standard deviation of returns in the six months leading up to the current period. The results do not show any unusual increase or spike in food price volatility after early 2007 when first signs of the food price crisis of 2007–2007 occurred. A similar pattern can be seen in conditional food price volatility (see Fig. A1 in the annex).

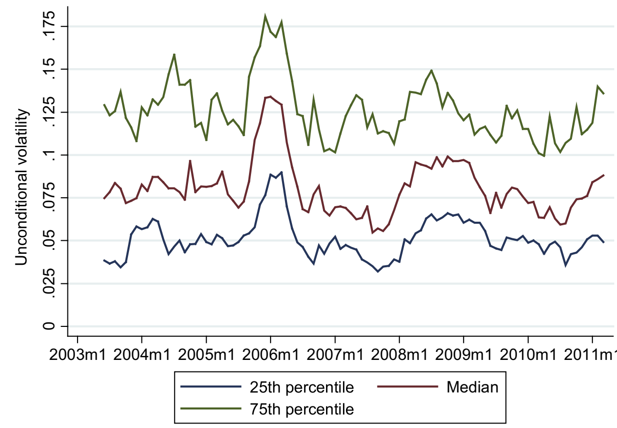

Fig. 8. Distribution of unconditional volatility across African food prices. *Source*: Analysis of price data from FEWS-NET (2011b) covering the period January 2003 to December 2010.

Summary and discussion

Summary

The global food crisis of 2007–2008 and the recent return of high prices in 2010–2011 has focused attention on food price instability. This paper explores the patterns of food price volatility in Africa and tests the idea that food price volatility has increased in recent years.

An analysis of prices of maize, rice, and wheat on international markets indicates that monthly unconditional price volatility was significantly higher during 2007–2010 compared with the previous four-year period (2003–2006) and compared with the long-term volatility during 1980–2006. Although these results confirm the conventional wisdom regarding international prices, they contrast with a few recent studies that find only limited evidence of increased volatility of international food prices (Gilbert and Morgan, 2010; OECD and FAO, 2011).

The volatility of wholesale and retail food prices in the eleven African countries examined is quite high. The average unconditional volatility of the 167 prices examined, measured by the standard deviation of the monthly proportional change in price, is 0.116, but the volatility is more than 0.141 in a full one-quarter of the prices. In contrast, the unconditional volatility of international grain prices is in the range of 0.06–0.08.

Among the price series examined, the commodities with the lowest volatility are processed goods (cooking oil and bread) and tradable commodities (wheat and rice). Millet and teff also have relatively low price volatility, perhaps because of their drought

Table 11
Change in unconditional volatility in aggregated food products in Africa between 2003–2006 and 2007–2010 measured at different frequencies. *Source:* Analysis of price data from FEWS-NET (2011b) covering the period January 2003 to December 2010.

Product	2-month volatility		*p*	4-month volatility		*p*	6-month volatility		*p*
	2003–06	2007–10		2003–06	2007–10		2003–06	2007–10	
Beans	0.223	0.185	0.00	0.312	0.251	0.00	0.357	0.288	0.00
Cooking oil	0.214	0.177	0.07	0.316	0.239	0.01	0.377	0.287	0.01
Maize	0.163	0.160	0.53	0.227	0.225	0.75	0.249	0.273	0.00
Millet	0.163	0.124	0.00	0.239	0.169	0.00	0.290	0.190	0.00
Rice	0.170	0.145	0.00	0.225	0.175	0.00	0.241	0.195	0.00
Sorghum	0.203	0.176	0.00	0.276	0.228	0.00	0.330	0.259	0.00
Total	0.179	0.155	0.00	0.249	0.208	0.00	0.288	0.243	0.00

resistance. Cowpeas, maize, and beans have the highest levels of price volatility among those studies.

Within our data set, the price volatility of tradable products (wheat, rice, and cooking oil) is significantly lower than that of nontradable commodities. This is not too surprising in light of the relatively low volatility of international commodity prices. However, this finding raises questions about whether staple food self-sufficiency would be an effective strategy to reduce price volatility.

Food price volatility is lower in the largest cities in each country than in the secondary cities, at least within the African countries examined in this analysis. This is presumably due to the fact that these large cities benefit from inflows from various regions with different seasonal supply patterns.

Kenya, Malawi, Zambia, and Zimbabwe have large state-owned trading enterprises that buy and sell maize and other staples in an attempt to stabilize prices. Somewhat surprisingly, we find that maize price volatility is significantly higher in these four countries, which intervene most actively in their maize markets, compared with other countries with little or no efforts to manage prices.

Although we find strong evidence that price volatility in international grain markets has increased since 2007, there is little or no evidence of increased price volatility in African staple food markets in the eleven countries examined. Of 67 prices tested, only 7 show statistically significant increases in unconditional volatility in 2007–2010, but 17 show significant decreases in volatility. Two-thirds of the prices examined (43 of 67) do not have any statistically significant change in volatility.

Of the six products tested, only maize shows a statistically significant increase in price volatility since 2007. Three commodities (beans, millet, and rice) show lower price volatility since 2007. Similar results were obtained when we examined the price volatility in 2008 compared with the rest of the period 2003–2010 and when measuring conditional volatility rather than unconditional volatility. In addition, calculating volatility at two-, four-, and six-month intervals rather than at monthly intervals does not affect the results. Nor is any apparent increase in volatility in graphs of the distribution of unconditional and conditional food price volatility over time.

Discussion

The most surprising result is that little or no evidence exists to show a statistically significant increase in food price volatility in Africa. Some prices have become more volatile during 2007–2010, but a larger number have become more stable.

One reason that this finding is unexpected is that international food markets have become more volatile in recent years. Given than most African countries are net food importers, it is natural to assume that the volatility in international food markets would be transmitted to domestic African markets. However, several studies have highlighted the low level of price transmission from international markets to African food markets (Quiroz and Soto, 1995; Conforti, 2004; Minot, 2011). For example, Minot (2011) found that only 13 of 62 African food prices showed a statistically significant long-term relationship with international prices. In light of this finding, it is quite plausible that African food prices have not become more volatile in spite of the increased price volatility in international food markets.

However, it is more difficult to reconcile the widespread view that food price volatility has increased in African markets with the lack of empirical support for this trend. We show that volatility measured at lower frequencies yields the same general trend. However, it is possible that price volatility has increased at a higher frequency (for example, weekly) that is not captured by our analysis. An analysis of weekly food price data from Africa would test this hypothesis.

Another possibility is that the conventional measure of volatility, the standard deviation of returns, does not match our intuitive understanding of what volatility is. For example, consumers may perceive a price increase from 200 to 220 to be a larger fluctuation than an increase from 80 to 88, even though they are equivalent in terms of the proportional return and in terms of the standard measure of volatility. In other words, our intuitive understanding of volatility may not be based on proportional changes but some combination of proportional and absolute changes.

A third possibility is that the apparent increase in volatility is a misconception. Volatility is not an easy concept to observe directly. Comparing the level of prices at two points in time requires just two data points, but comparing the degree of volatility requires a comparison of two sets of data points. In other words, it may be that the widespread view that African food prices have become more volatile is just a misconception that has become reinforced by repetition in the media. Although further research is warranted, this seems the most likely explanation.

What are the implications of these findings for food policy and price stabilization programs? First, at the international level, they suggest that greater attention should be paid to the degree to which price volatility in international markets is transmitted to markets in developing countries. To the extent that our findings for eleven countries in Africa are replicated for other countries and regions, there may be less reason for concern about price volatility in international food markets.

At the regional and national levels, the results imply that greater attention should be given to the level of food prices (particularly high food prices) in Africa rather than price volatility per se, since any adverse effects of the crisis must have been driven by the level of food prices rather than volatility. Food price volatility remains an issue, but it is arguably no more of an issue now than it was before the global food crisis of 2007–2008.

Of course, these findings do not necessarily undermine the rationale for efforts to reduce food price volatility. Food price volatility is higher in African than in other regions of the world and much higher than in international food markets. Many of the proposals in the G20 Action Plan, such as the strengthening of safety net programs and better information about prices and stock levels, would be advisable regardless of the trend in food price volatility.

However, the results suggest that food self-sufficiency is not a promising strategy for reducing food price volatility. Within the prices and countries covered by this study, international food prices are more stable than African food prices, and within Africa, the prices of tradable foods (such as rice, wheat, and cooking oil) are less volatile than the prices of commodities for which countries are self-sufficient (beans, cowpeas, sorghum, and millet). Thus, the results support the argument that international trade can play a useful role in stabilizing food prices.

Regional trade can also contribute to reducing food price volatility. The finding that food prices are more stable in large cities than in small cities is probably due to the better transport infrastructure and the greater level of integration with different nearby markets. Reducing barriers to cross-border trade would increase the level of integration of smaller cities with nearby cities in other countries, facilitating food inflows in times of shortage and outflows in times of surplus.

Finally, the results raise questions about the effectiveness of traditional food price stabilization programs. Four countries in our sample have large state-owned enterprises that attempt to stabilize prices, particularly maize prices, by buying when the price is low and selling when the price is high. Yet maize price volatility is significantly higher in these countries than in African countries with little or no maize price stabilization efforts. It is possible that these countries have inherently more instable food markets, prompting the stabilization efforts. Alternatively, the results may indicate that these stabilizations efforts have been counter-productive. A number of studies that suggest that unpredictable government intervention in maize markets and trade restrictions that often accompany these policies can inhibit private traders from participating in trade and storage activities, which increases seasonal volatility and exacerbates price spikes associated with supply shortfalls.

Naturally, our ability to generalize the results and policy insights from this analysis to the whole continent is constrained by the possibility that the study's sample of countries and markets may not be fully representative and that the time periods covered in the study may be too short. Extending the analysis to a larger set of markets and longer periods would provide more robust conclusions.

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Appendix: Tests of conditional price volatility

Tests of differences in conditional price volatility were implemented with Stata software. The GARCH(1,1) estimation of the returns, *r*, was carried out for each price series with the command `arch r, arch(1) garch(1)`. Then, the predicted conditional

Table A1
Conditional price volatility in international grain prices. Source: Analysis based on data from FEWS-NET (2011b).

	N	1980–2006	2007–2010	*F* stat	*p*
Maize	372	0.057	0.061	0.88	0.51
Rice	372	0.054	0.079	0.48	0.00
Wheat	372	0.051	0.078	0.43	0.00
IMF food index	372	0.027	0.036	0.58	0.01
	N	2003–2006	2007–2010	*F* stat	*p*
Maize	96	0.057	0.061	0.87	0.64
Rice	96	0.041	0.079	0.27	0.00
Wheat	96	0.052	0.078	0.45	0.01
IMF food index	96	0.027	0.036	0.56	0.05

Table A2
Conditional price volatility across products. Source: Analysis based on data from FEWS-NET (2011b).

	Nbr of obs	Nbr of prices	Volatility	*F* stat	*p*
Beans	600	8	0.128	0.713	0.00
Bread	75	1	0.030	13.231	0.00
Cooking oil	300	4	0.094	1.352	0.00
Cowpeas	225	3	0.228	0.215	0.00
Maize	2175	29	0.116	0.845	0.00
Millet	1800	24	0.098	1.320	0.00
Rice	1725	23	0.095	1.406	0.00
Sorghum	1125	15	0.121	0.788	0.00
Teff	225	3	0.080	1.898	0.00
Wheat	225	3	0.087	1.575	0.00
Total	8475	113	0.126	0.000	0.00

Table A3
Conditional price volatility of tradable and nontradable products. Source: Analysis based on data from FEWS-NET (2011b).

	Nbr of obs	Nbr of prices	Volatility	*F* stat	*P*
Non-tradables	6225	83	0.114	0.000	0.00
Tradable products	2250	30	0.094	1.479	0.00
Total	8475	113	0.109	0.000	0.00

Table A4
Conditional price volatility of maize by country. Source: Analysis based on data from FEWS-NET (2011b).

	Nbr of obs	Nbr of prices	Volatility	*F* stat	*p*
Chad	150	2	0.120	0.92	0.48
Ethiopia	225	3	0.091	1.71	0.00
Kenya	375	5	0.092	1.74	0.00
Malawi	300	4	0.188	0.31	0.00
Mozambique	525	7	0.107	1.25	0.00
Niger	225	3	0.091	1.70	0.00
Nigeria	75	1	0.101	1.34	0.10
Uganda	75	1	0.090	1.67	0.01
Zambia	225	3	0.143	0.62	0.00
Total	2175	29	0.116	0.00	0.00

Table A5
Conditional maize price volatility by level of intervention. Source: Analysis based on data from FEWS-NET (2011b).

	Nbr of obs	Nbr of prices	Volatility	*F* stat	*p*
Low	1275	17	0.101	0.00	0.00
High	900	12	0.137	0.00	0.00
Total	2175	29	0.116	0.55	0.00

Table A6
Conditional price volatility in coastal and landlocked countries by product. Source: Analysis based on data from FEWS-NET (2011b).

	Nbr obs	Nbr prices	Coastal	Landlocked	*F* stat	*p*
Beans	0	0	0.000	0.000	0.00	0.00
Bread	0	0	0.000	0.000	0.00	0.00
Cooking oil	0	0	0.000	0.000	0.00	0.00
Cowpea	225	3	0.214	0.256	0.70	0.07
Maize	2175	29	0.100	0.129	0.61	0.00
Millet	1800	24	0.116	0.095	1.48	0.00
Rice	1725	23	0.125	0.075	2.78	0.00
Sorghum	1125	15	0.138	0.115	1.44	0.00
Teff	0	0	0.000	0.000	0.00	0.00
Wheat	225	3	0.117	0.073	2.59	0.00

Table A7
Conditional price volatility in the largest city and other cities by product. Source: Analysis based on data from FEWS-NET (2011b).

	Nbr obs	Nbr prices	Largest city	Other cities	*F* stat	*p*
Beans	600	8	0.088	0.133	0.44	0.00
Cooking oil	300	4	0.084	0.098	0.74	0.13
Maize	2175	29	0.094	0.121	0.61	0.00
Millet	1800	24	0.102	0.097	1.10	0.40
Sorghum	1125	15	0.174	0.117	2.21	0.00
Wheat	225	3	0.117	0.073	2.59	0.00
Total	8434	0	0.097	0.110	0.77	0.00

Table A8
Changes in conditional price volatility between 2003–2006 and 2007–2010 by product. Source: Analysis based on data from FEWS-NET (2011b).

	Nbr obs	Nbr prices	2003–2006	2007–2010	*F* stat	*p*
Beans	480	5	0.118	0.108	1.19	0.17
Maize	1536	16	0.102	0.101	1.02	0.74
Millet	1248	13	0.097	0.087	1.26	0.00
Rice	768	8	0.102	0.090	1.29	0.01
Sorghum	576	6	0.139	0.129	1.16	0.21
Overall	4608	48	0.107	0.100	1.16	0.00

Table A9
Changes in conditional price volatility between 2003–2010 and 2008 by product. Source: Analysis based on data from FEWS-NET (2011b).

	Nbr obs	Nbr prices	2003–2010	2008	*F* stat	*p*
Beans	495	5	0.113	0.112	1.01	1.00
Maize	1584	16	0.101	0.105	0.92	0.40
Millet	1287	13	0.092	0.092	1.00	0.97
Rice	792	8	0.096	0.099	0.94	0.65
Sorghum	594	6	0.134	0.133	1.03	0.92
Overall	4752	48	0.103	0.105	0.97	0.58

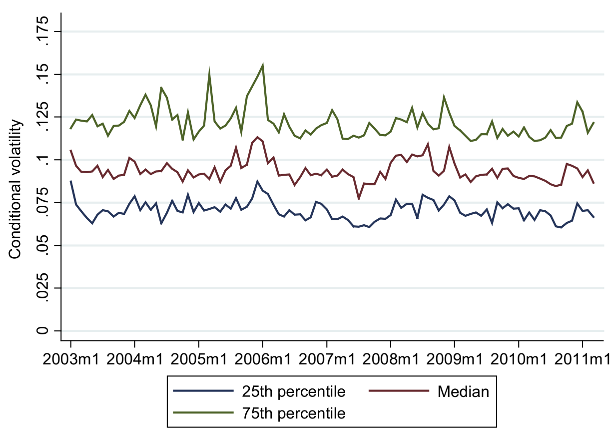

Fig. A1. Distribution of conditional volatility across African food prices. *Source*: Analysis based on GARCH(1,1) analysis of 50 food prices from FEWS-NET (2011b).

variance for each observation was stored in the variable *h* with the command `predict h, variance`. Finally, an *F*-test of differences in the conditional variance across groups of price series was performed using the command `vartest h, by(group)`. Additional information is available from the author upon request. See Tables A1–A9 and Fig. A1.

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