Food price volatility in sub-Saharan Africa:

Has it really increased?

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1 Introduction

1.1 Background

As a result of the global food crisis of 2007-09 and the resurgence of food prices in 2010, there is unprecedented interest and concern over high and volatility 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, is dedicated to the impact of volatile food prices on food security in developing countries (FAO et al, 2011a). The *2011 Agricultural Outlook,* 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 Report prepared by the International Food Policy Research Institute (IFPRI) adopts food price volatility as the special theme for this year (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 sub-Saharan 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 the purchasing power of household income (FAO et al, 2011b: 14). Third, the share of the population that depends on agriculture for its livelihood is generally larger in sub-Saharan 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 non-farm 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 over the 1970-89 period. They also test the difference between volatility over 2007-09 and previous years. Of the 19 commodities tested, only three showed a statistically significant increase in volatility (soybeans, soybean oil, and groundnut oil).

The OECD-FAO (2011) report acknowledges that there is no long-term trends toward increased volatility, but it notes that the "implied volatility" associated with futures prices of wheat, maize, and soybeans has been rising steadily since 1990[1]. FAO et al (2011a) notes that there is little or no evidence of a long-term increase in the volatility of international food prices, but argues that "there is no doubt that the period since 2006 has been one of extraordinary volatility" (p 8).

To what degree has volatility in international prices been transmitted to food markets in sub-Saharan Africa? 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 sub-Saharan Africa have become more volatile in recent years (see Gerard et al, 2011 and G20, 2011). However, there have been few if any empirical studies of the trends and patterns in food price volatility in sub-Saharan Africa using recent data. FAO et al (2011a: 22) provide a graph showing that the average volatility of the price of wheat, maize, and rice rose in 2008 before falling again in 2009, but they do not test the statistical significance of the change.

The answer has important implications for policy. The trends in food prices since 2007 have revived interest in regulating food markets in sub-Saharan Africa. As Gerard et al (2010) note:

> 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 (p 11).

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, 2008). Gerard et al (2010) argues that the high and volatile prices of food strengthen the

[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.

case for government intervention to stabilize food prices in developing countries, in spite of the practical difficulties of doing so.

1.2 Objectives

The goal of this paper is to describe the patterns and trends in food price volatility in sub-Saharan 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 2007-08.

First, the definition and measurement of food price volatility is discussed. Then, we review the data used in this analysis: an unusually rich set of food prices collected by the Famine Early Warning System Network (FEWS-NET), funded by the United States Agency for International Development. Then, the results of the analysis are presented, including both patterns across commodities and locations and trends over the last decade. Finally, we summarize the results and discuss the implications.

2 Data and methods

2.1 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 sub-Saharan Africa. Although cassava and other root crops are important staples in many countries in the region, they cannot be stored long after harvest and, for this reason, are not the focus of government efforts to stabilize food prices. As discussed later, cassava does play an important role in helping households adapt to grain price instability.

Variation is often measured using the coefficient of variation (CV), defined as follows:

$$CV = s/\mu$$

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 size of the sample.

An alternative measure of variability, often used in the analysis of prices in financial markets, 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 volatility, can be expressed as follows:

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

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.

Volatility in food prices can be measured at the producer, wholesale, or retail level. In sub-Saharan 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. The data used in this analysis are monthly.

2.2 Data sources

This analysis is largely based on monthly prices of staple food commodities in markets in sub-Saharan Africa were obtained from 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 compiled from statistical agencies in each of the countries where it operated.

The analysis focuses on ten staple food: beans, bread, cooking oil, cowpeas, maize, millet, rice, sorghum, teff, and wheat. Bread and cooking oil were included in order to explore whether the prices of processed foods are more volatile than 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 for which there are 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 prices 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 which include at least 90% of the observations between January 2003 and December 2010. This leaves 67 price series from eleven countries: Chad, Kenya, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Tanzania, Uganda, and Zambia. This data set includes prices for six staple foods: beans, cooking oil, maize, millet, rice, and sorghum.

2.3 Analysis

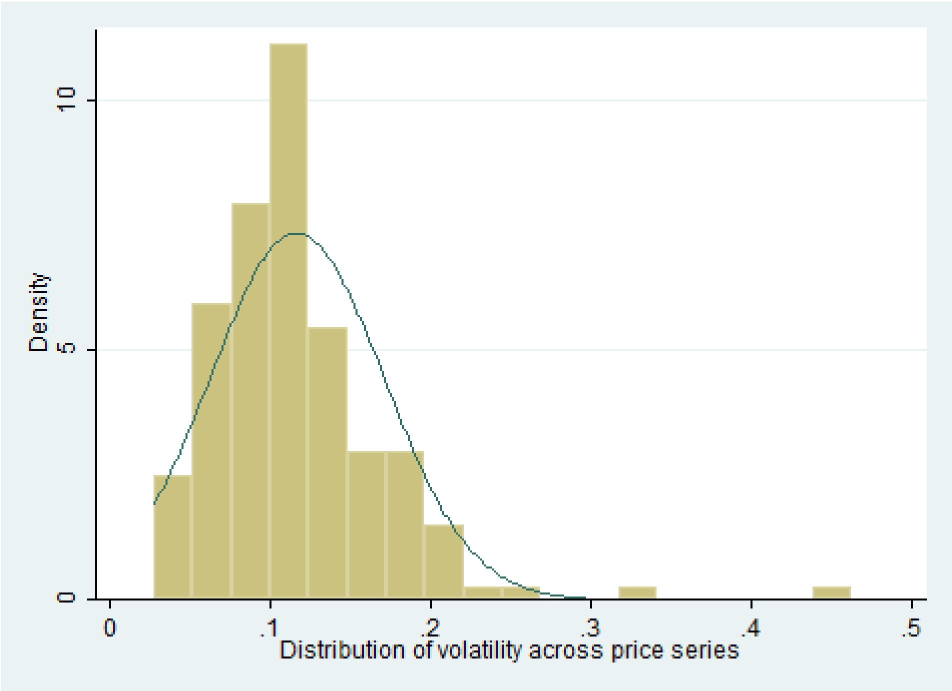
In order to test the differences between the volatility of different prices, we test the null hypothesis that the two groups have the same standard deviation and use the F-statistic to test the probability that the null hypothesis is true, using a 5% confidence threshold. This approach tests the unconditional standard deviation of the returns, equivalent to a test of the variance of returns. An alternative approach, used by Gilbert and Morgan (2010) is to test the *conditional* variance of returns within a generalized auto-regressive conditional heteroskedasticity (GARCH) model. However, preliminary tests indicate that the two test agree in almost all cases, so we adopted the simpler and more intuitive test of the unconditional variance of returns.

3 Results

3.1 Distribution of food price volatility

As described above, the analysis of the cross-sectional patterns in African staple crop volatility 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. One quarter of the volatility measures are below 0.085, and three-quarters are below 0.141.

Figure 1. Distribution of volatility across 167 African staple prices



These results confirm that staple food prices are generally more volatile than the price of major cereals on the international markets. The volatility of maize on international markets over this same time period is 0.073, while that of rice and wheat are both 0.082[2].

In order to provide a visual illustration of the range of volatility, Figure 2 shows the retail price of millet in Timbuktu (Mali). The volatility of this price over 2005-2011 is 0.058,

[2] These prices are No. 2 yellow maize FOB New Orleans, 5% broken milled while rice FOB Bangkok, and No. 1 hard red winter wheat (ordinary protein) (IMF, 2011).

Figure 2. Retail price of millet in Timbuktu (Mali)

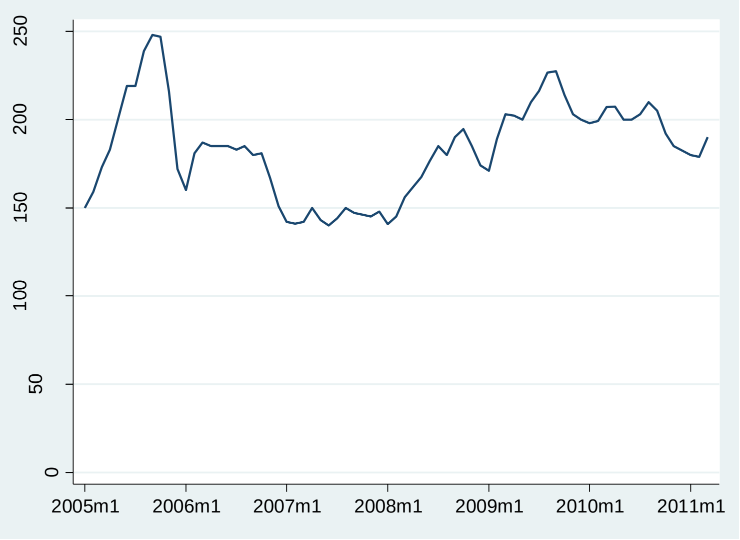


Figure 3. Returns to millet in Timbuktu

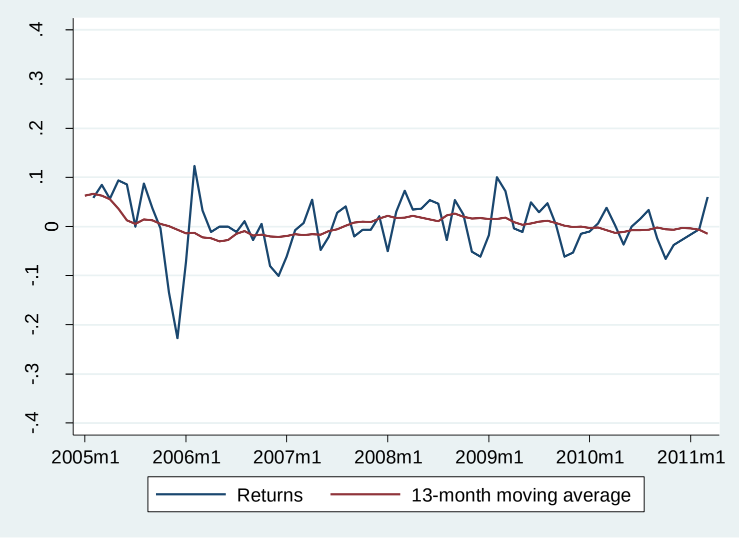


Figure 4. Volatility of the millet price in Timbuktu

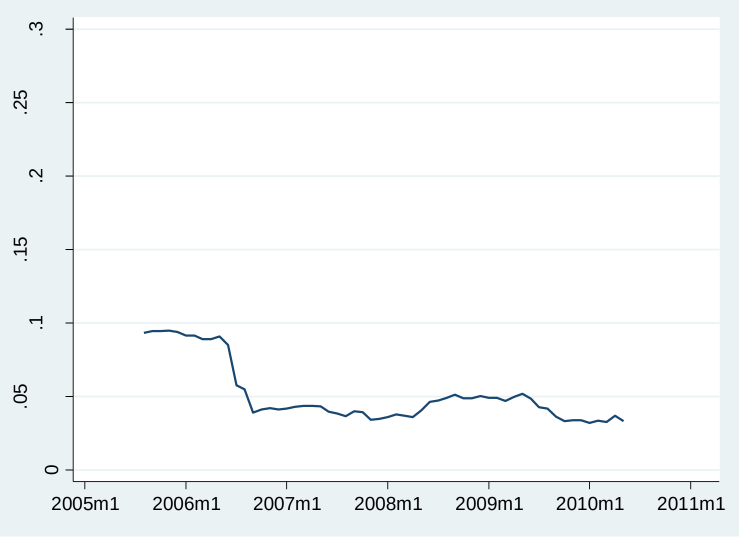


Figure 5. Retail price of rice in Nampula (Mozambique)

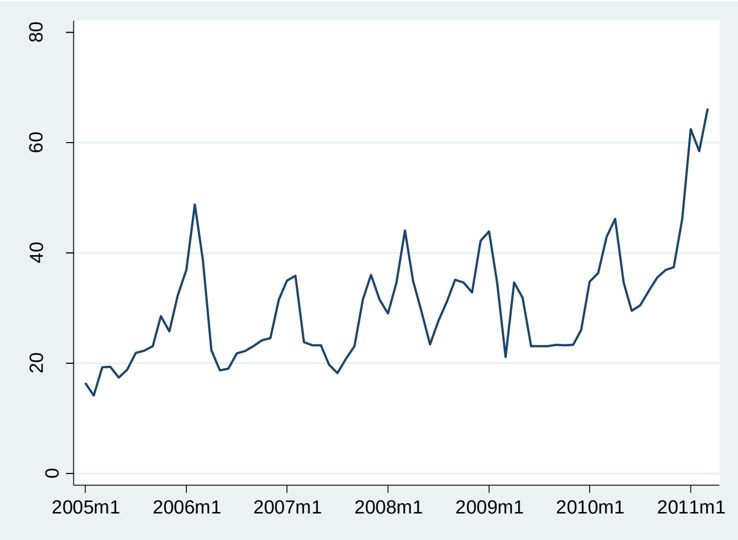


Figure 6. Returns to rice in Nampula

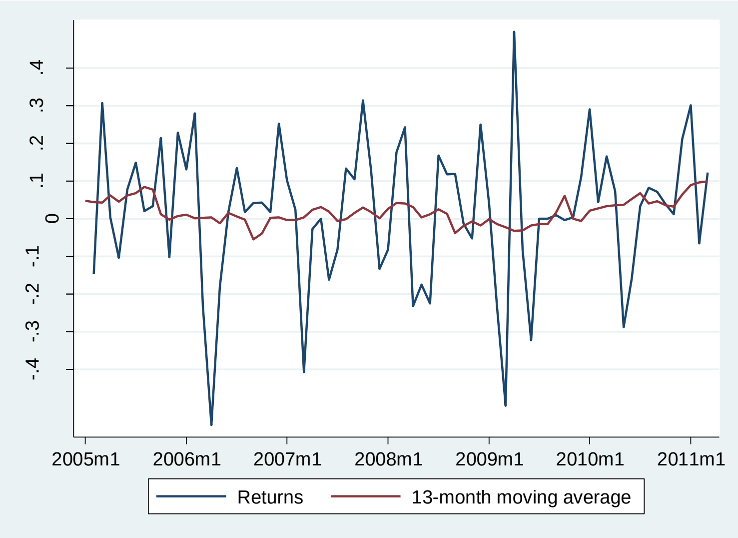
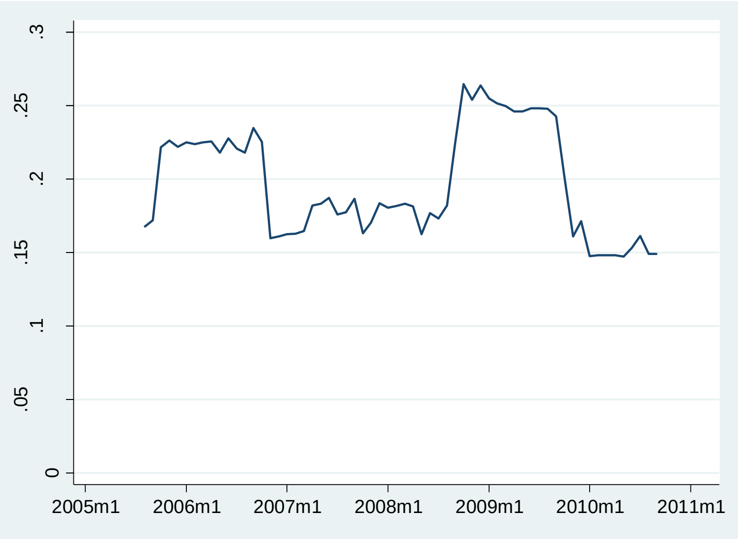


Figure 7. Volatility of the price of rice in Nampula



placing it at the 10th percentile and among the most stable prices in the data set. Figure 3 and Figure 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. Figure **5** though Figure 7 show the retail price, returns, and the moving average volatility for rice in Nampula.

3.2 Price volatility for different commodities

How does price volatility vary across commodities? Table 1 shows the price volatility over 2005-2010 for each product for 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, price volatility is lowest for bread (0.028), wheat (0.094), and cooking oil (0.102). It is interesting to note that the processed foods are among those with the most stable prices. One hypothesis is that this is related to the fact that the raw material accounts for a relatively small share of the total costs and that other components of food processing costs (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, three for wheat, and eight for cooking oil.

The prices of teff, millet, and rice are also less volatile than the average. The relatively low price volatility for millet and teff are 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 semi-arid 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 sub-Saharan Africa. As discussed above, in spite of recent increases in volatility in world markets, world grain prices remain more stable than African grain prices.

The volatility of sorghum price is 1.24, higher than that of millet (0.105) but lower than that of maize (0.144), which might be expected given the fact that it is less drought-tolerant than millet but more so than maize. Along with maize, cowpeas and beans have the highest price volatility according to the sample of prices analyzed here. The differences between beans and cowpeas may reflect regional differences in rainfall. Cowpeas have the highest price volatility of the commodities considered, which may be partly due to the fact that all five cowpea prices are from Niger. In contrast, the 12 bean prices are from Kenya, Rwanda, and Mozambique, where drought and weather-related shortages are perhaps less frequent.

Table 1. Price volatility across products

Products	N	Nbr of prices	Volatility	F-stat	p
Beans	878	12	0.133	0.90	0.04 **
Bread	149	2	0.028	21.31	0.00 ***
Cooking oil	592	8	0.102	1.59	0.00 ***
Cowpea	369	5	0.230	0.28	0.00 ***
Maize	3,450	47	0.144	0.69	0.00 ***
Millet	2,224	30	0.105	1.55	0.00 ***
Rice	2,202	30	0.108	1.45	0.00 ***
Sorghum	1,914	26	0.124	1.05	0.21
Teff	296	4	0.104	1.49	0.00 ***
Wheat	224	3	0.094	1.84	0.00 ***
	12,298	167	0.127		

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 national supply of wheat and rice in most countries in sub-Saharan Africa. In addition, imported cooking oil accounts for more than 40% of the total consumption in sub-Saharan Africa. In contrast, , the four products with the highest price volatility (cowpeas, maize, beans, and sorghum) are generally considered non-tradable. 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. provides a test of the level of price volatility in tradable goods (rice, wheat, and cooking oil) compared to the other commodities. The price volatility of tradables is 0.106, while that of non-tradables is 0.133, a difference that is statistically significant at the 1% level.

Table 2. Price volatility of tradable and non-tradable products

Products	N	Nbr of prices	Volatility	F-stat	p
Non-tradables	9,280	126	0.133		
Tradable goods	3,018	41	0.106	1.5678	0.00 ***
	12,298	167	0.127		

Volatility in 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 non-tradable commodities is mainly determined by domestic supply and demand conditions, particularly weather-related fluctuations in supply. These findings challenge the widespread view that instability in international markets is the main source of price volatility in sub-Saharan Africa and the policy implication that food self-sufficiency would reduce food price volatility.

3.3 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 land-locked countries, and differences between price volatility in the capital city and volatility in other 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. For this reason, the volatility in the price of maize is more politically important than volatility in the price of other food commodities.

Table 3 shows the volatility in maize prices in 11 countries, along with a statistical test of whether the difference between volatility in that country and volatility in the other countries is statistically significant. The highest price volatility is found in Zimbabwe (0.462), followed by Malawi (0.197), Zambia (0.137), and Chad (1.32).

Table 3. Volatility in maize prices by country

Country	N	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	0.07 *
Zimbabwe	69	1	0.462	0.08	0.00 ***
Total	3,450	47	0.133		

The extremely high volatility in maize prices in Zimbabwe is probably be 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 monopoly on virtually maize trade (it was legal for farmers to market quantities up to 150 kg). These policies continued until market reforms were introduced in 2010.

In Malawi, the Agricultural Development and Marketing Corporation (ADMARC) plays an important role in maize marketing and trade. Its role has fluctuated between serving remote areas to stabilizing prices. 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.

In Zambia, the Food Reserve Agency plays a similar role, obtaining maize from large-scale commercial farmers and from imports, while distributing them at pan-territorial prices in remote areas.

In contrast, countries such as Uganda, Mozambique, and Tanzania have more stable maize prices, with volatility in the range of 0.092 to 0.114. Uganda and Mozambique have no state marketing board responsible for maize marketing, nor do they maintain food reserves. Tanzania does maintain a strategic food reserve, but the size of the operations has been quite small relative to the size of the maize economy.

However, Ethiopia and Kenya also have maize price volatility in this same range (0.095 and 0.117, respectively). Like Malawi and Zambia, these two countries have state trading enterprises who attempt to stabilize prices.

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. Ethiopia, Kenya, Malawi, Zambia, and Zimbabwe can be classified into the former category. As shown in Table 4, maize price volatility is actually higher (0.163) in countries where the government intervenes more actively in maize markets than in countries with relatively little intervention (0.117).

Table 4. Maize price volatility by level of intervention in maize markets

Level of intervention	N	Prices	Volatility	F stat	p
Low	1556	21	0.117		
High	1894	26	0.163		
Total	3450	47	0.144	0.52	0.00 ***

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

There are at least two ways to interpret these results. 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 counter-productive. The uncertainty created by government intervention in maize markets can cause private traders to withdraw from the market, reducing the effect of temporary arbitrage in smoothing prices over time.

Coastal vs 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 5. In the case of beans, bread, cooking oil, and cowpeas, there is no significant difference between price volatility in coastal and landlocked countries. Furthermore, in the case of millet, rice, sorghum, and wheat, prices are significantly *less* volatile in landlocked countries. It is only in the case of maize that price volatility is higher in landlocked countries (0.161) than in coastal countries (0.116), a difference that is statistically significant.

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.

Table 5. Volatility in coastal and landlocked countries by product

			Volatility			
Product	N	Prices	Coastal	Landlocked	F stat	p
Beans	878	12	0.134	0.121	1.23	0.28
Bread	149	2	0.029	0.027	1.14	0.56
Cooking oil	592	8	0.105	0.098	1.16	0.20
Cowpea	369	5	0.246	0.218	1.27	0.10
Maize	3450	47	0.116	0.161	0.52	0.00 ***
Millet	2224	30	0.125	0.100	1.55	0.00 ***
Rice	2202	30	0.141	0.084	2.82	0.00 ***
Sorghum	1914	26	0.144	0.115	1.56	0.00 ***
Wheat	224	3	0.122	0.076	2.60	0.00 ***

Large city vs small city

Another way to group markets is by the size of the population. 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 6, prices are less volatile in the largest city than in other cities in the case of six commodities: beans, cooking oil, maize, rice, sorghum, and teff. Only millet and wheat do not show any statistically significant difference.

The most likely explanation is that the largest city draws surplus food from various parts of the country. Assuming some variation in agro-ecological 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.

Table 6. Price volatility in the largest city and other cities by product

Product	N	Prices	Volatility		F stat	p	
			Largest city	Other cities			
Beans	878	12	0.099	0.143	0.48	0.00	***
Cooking oil	592	8	0.070	0.125	0.32	0.00	***
Maize	3,450	47	0.098	0.151	0.42	0.00	***
Millet	2,224	30	0.103	0.106	0.96	0.68	
Rice	2,202	30	0.071	0.116	0.38	0.00	***
Sorghum	1,914	26	0.116	0.126	0.84	0.05	**
Teff	296	4	0.064	0.115	0.32	0.00	***
Wheat	224	3	0.095	0.092	1.08	0.74	
Total	11,780	160	0.091	0.135	0.45	0.00	***

3.4 Changes in price volatility over time

It is widely accepted that food prices on the international market and in domestic African markets have become more volatile since the global food crisis of 2007-2008. In order 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 over 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 over 2003-2006 to the level over 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 2010-11.

Table 7 confirms 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, it is surprising to note that only seven of the 67 prices tested showed a statistically significant increase in volatility between 2003-2006 and 2007-2010. Furthermore, there are 17 prices which show a statistically significant decrease in volatility between these two periods. For example, price volatility fell for maize in Maputo, rice in Ndjamena, and sorghum in Nouakchott. The remaining 43 prices tested did not show any statistically significant change in volatility between 2003-2006 and 2007-2010.

It could be argued that the number of observations is not sufficient to test changes in volatility. Three pieces of evidence suggest that this is not the explanation. First, if volatility rose between the two period 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, volatility declined in 50 of the prices and increased in only 17 (see Table 7).

Second, if price volatility increased, but could not be measured because of the small sample, then we would expect to be able to measure the increase in volatility for prices with a longer time series. Six price series (all from Kenya) are available for the eleven-year period 2000-2010. If we compare the level of volatility over 2000-2006 with volatility over 2007-2010, price volatility increased significantly in maize markets in Marsabit and decreased in maize markets of Lodwar, and there was no statistically significant change in the other four markets.

Table 7. Change in volatility in staple food prices in sub-Saharan Africa between 2003-06 and 2007-10

					Volatility					
Product	Country	Market	Level	N	2003-06	2007-10	F_stat	p		Result
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	***	Less in 2007-10
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	***	More in 2007-10
Maize	Kenya	Lodwar	Retail	99	0.114	0.084	1.85	0.04	**	Less in 2007-10
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	***	More in 2007-10
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	***	More in 2007-10
Maize	Mozambique	Gargongosa	Retail	99	0.077	0.130	0.35	0.00	***	More in 2007-10
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	***	Less in 2007-10
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	***	More in 2007-10
Maize	Niger	Niamey	Retail	99	0.078	0.071	1.21	0.52		
Maize	Tanzania	Dar es Salaam	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	***	Less in 2007-10
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	***	Less in 2007-10
Millet	Mali	Gao	Retail	99	0.087	0.060	2.13	0.01	***	Less in 2007-10
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	***	Less in 2007-10
Millet	Mali	Mopti	Retail	99	0.081	0.047	2.89	0.00	***	Less in 2007-10
Millet	Mali	Segou	Retail	99	0.114	0.073	2.41	0.00	***	Less in 2007-10
Millet	Mali	Sikasso	Retail	99	0.083	0.057	2.10	0.01	**	Less in 2007-10
Millet	Mali	Timbuktu	Retail	97	0.079	0.041	3.67	0.00	***	Less in 2007-10

Table 3. Change in volatility in individual food prices in sub-Saharan Africa between 2003-06 and 2007-10 (continued)

	Country	Market	Level	N	Volatility 2003-06	2007-10	F_stat	p		Result
Millet	Niger	Agadez	Retail	99	0.100	0.069	2.09	0.01	**	Less in 2007-10
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	***	Less in 2007-10
Rice (local)	Chad	N'Djamena	Retail	99	0.148	0.075	3.84	0.00	***	Less in 2007-10
Rice (local)	Niger	Agadez	Retail	99	0.026	0.048	0.30	0.00	***	More in 2007-10
Rice	Mali	Segou	Retail	99	0.085	0.043	3.84	0.00	***	Less in 2007-10
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	***	More in 2007-10
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	***	Less in 2007-10
Sorghum	Niger	Maradi	Retail	94	0.112	0.080	1.97	0.02	**	Less in 2007-10
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		

Third, we can increase the sample size by aggregating the data to the product level or by aggregating all 67 price series together. Table 8 shows the aggregated results for each of the six products and then aggregated across all products. Price volatility increased significantly between 2003-06 and 2007-10 in the case of maize, but price volatility declined in the cases of beans, millet, and rice. In the case of cooking oil and sorghum, there was no statistically significant change in price volatility.

Table 8. Change in volatility in aggregated food prices in sub-Saharan Africa between 2003-06 and 2007-10

			Volatility					
Product	N	Prices	2003-06	2007-10	F stat	p		
Beans	781	8	0.146	0.121	1.45	0.00	***	Less in 2007-10
Cooking oil	196	2	0.135	0.122	1.21	0.35		
Maize	2,154	22	0.114	0.122	0.87	0.02	**	More in 2007-10
Millet	1,776	18	0.107	0.083	1.68	0.00	***	Less in 2007-10
Rice	882	9	0.128	0.106	1.46	0.00	***	Less in 2007-10
Sorghum	776	8	0.148	0.138	1.15	0.17		
Total	6,565	67	0.123	0.113	1.20	0.00	***	Less in 2007-10

It is difficult to explain why only maize price volatility increased in the period 2007-10. One possible factor is that maize is the most politically sensitive staple food in many countries, particularly those in eastern and southern Africa. Normally, this results in greater efforts to stabilize the price and/or control its level through buying and selling operations by state-owned trading enterprises. However, the fact that maize price volatility has increased could be explained if a) stabilization efforts declined between the first period and the second or b) stabilization efforts increased, but had counter-productive effects in terms of price volatility. Given the increased interest in building up stocks and reducing price instability as a result of the food crisis of 2007-08, the first hypothesis does not seem plausible. Therefore, it is important to further explore the possibility that the policy responses to the food crisis have, in the case of maize, been counter-productive.

Another way to reconcile the contrast between the widespread view that food price volatility increased in the wake of the global food crisis and the lack of evidence to support this view is to revise the time period. Perhaps the increase in price volatility did not last five years (2007-2010), but rather just one year (2008). Table 9 shows the results of tests 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.

Table 9. Change in volatility in aggregated food products in sub-Saharan Africa between 2003-10 and 2008

			Volatility					
Product	N	Prices	2003-10	2008	F stat	p		
Beans	781	8	0.137	0.109	1.58	0.01	***	Less in 2008
Cooking oil	196	2	0.127	0.138	0.85	0.55		
Maize	2,154	22	0.117	0.122	0.91	0.31		
Millet	1,776	18	0.095	0.099	0.92	0.42		
Rice	882	9	0.120	0.098	1.48	0.01	**	Less in 2008
Sorghum	776	8	0.146	0.118	1.51	0.01	**	Less in 2008
Total	6,565	67	0.119	0.112	1.13	0.03	**	Less in 2008

4 Summary and discussion

4.1 Summary

The global food crisis of 2007-08 and the recent return of high prices in 2010-11 has focused attention on the topic of food price instability. The coefficient of variation (a measure of volatility) for staple grain prices in sub-Saharan Africa ranges between 25% and 50%. This food price instability is much higher than in Asia, where the CV of rice prices is 5-25%. It is also higher than price instability in some countries in Latin America.

The volatility of wholesale and retail food prices in sub-Saharan Africa is quite high. Across 167 prices examined, the average volatility, measured by the standard deviation of the proportional change in price, is 0.116, but the volatility is over 0.141 in fully one-quarter of the prices. By contrast, the volatility of international grain prices is in the range of 0.05 to 0.08.

The commodities with the lowest volatility are processed goods (cooking oil and bread) and tradable commodities (wheat and rice). Millet and sorghum also have relatively low price volatility, perhaps because of their drought resistance. Cowpeas, maize, and beans have the highest levels of price volatility among the commodities examined.

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

Food price volatility is lower in the largest cities in each country than in the secondary cities. This is presumably due to the fact that they benefit from inflows from various regions with different seasonal patterns.

Five countries have large state 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 those countries that intervene most actively in their maize markets compared to other countries with little or no efforts to manage prices.

Although there is clear evidence that price volatility in international grain markets has increased since 2007, there is little evidence of increased price volatility in African staple food markets. Of 67 prices tested, only 7 showed a statistically significant increase in volatility in 2007-10 and 17 shows significant decreases n volatility.

Of the six products tested, only maize showed a statistically significant increase in price volatility since 2007. Three commodities showed lower price volatility since 2007.

4.2 Discussion

The most surprising result is that there is little or no evidence of a statistically significant increase in food price volatility in sub-Saharan Africa. Some prices have become more volatile over 2007-2010, but a larger number have become more stable. It is not difficult to accept that international food prices have become more volatile, while African food prices have not. Several studies have highlighted the low level of price transmission from international markets to African food markets (see Minot, 2011).

However, it is more difficult to reconcile the widespread view that food prices volatility has increased in African markets with the lack of empirical support for this trend. Perhaps the standard 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 (10%) 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.

Another possibility is that food price volatility has increased at a higher frequency (e.g. weekly) that is not captured by our analysis which uses monthly price data. An analysis of weekly food price data from sub-Saharan Africa would test this hypothesis, but this does not seem to be a satisfying explanation since high-frequency price data are more difficult to observe than monthly data.

A third possibility is that the apparent increase in volatility is a misperception. 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 simply based on a misperception which has become reinforced by its own ubiquity.

These findings do not necessarily undermine the rationale for efforts to reduce food price volatility. Food prices are much more volatile in sub-Saharan Africa than in other regions and much more volatile than commodity prices on international markets. It remains true that low income households in sub-Saharan Africa (particularly those in urban areas) are among the most vulnerable to volatile food prices. Many of the proposals in the G20 Action Plan, such as social safety nets and better information about prices and stock levels, would be advisable regardless of the trend in food price volatility. At least in the case of sub-Sahara, however, it appears that the urgency to reduce volatility in food prices may be no greater (nor any less) now than it was 10 years ago. In addition, the fact that international prices are far less volatile than domestic African food prices suggests that trade could play a useful role in stabilizing food prices.

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