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IFPRI Discussion Paper 01059

January 2011

Transmission of World Food Price Changes to Markets in Sub-Saharan Africa

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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PARTNERS AND CONTRIBUTORS

IFPRI gratefully acknowledges the generous unrestricted funding from Australia, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, the Netherlands, Norway, the Philippines, South Africa, Sweden, Switzerland, the United Kingdom, the United States, and the World Bank.

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ABSTRACT

The global food crisis of 2007–2008 was characterized by a sharp spike in the prices of most commodities, including staple grains. This analysis examines the degree to which changes in world food markets influence the price of staple foods in Sub-Saharan Africa. The analysis is based on more than 60 price series from 11 African countries. After examining price trends over 2007–2008, we use an error correction model to estimate the degree of price transmission. The results of this analysis indicate the following:

- Staple food prices in these countries rose 63 percent between mid-2007 and mid-2008, about three-quarters of the proportional increase in world prices.
- Statistical analysis over 5 to 10 years indicates a long-term relationship with world prices in only 13 of the 62 African food prices examined. African rice prices are more closely linked to world markets than are maize prices.
- The global food crisis was unusual in influencing African food prices, probably because of the size of the increase and the fact that it coincided with oil price increases. Policy responses and local factors exacerbated the effect in some cases.

This suggests that African governments can reduce vulnerability to external food price shocks by investing in agricultural research, pursuing more predictable policies, facilitating grain trade, and promoting diversification in staples consumption. Trade-based food self-sufficiency policies will raise food prices but without necessarily reducing price volatility.

Keywords: staple food, food prices, price transmission, food crisis, error correction model, Sub-Saharan Africa

ACKNOWLEDGEMENTS

This study was funded by the Policy and Research Division of the Department for International Development (DfID) of the United Kingdom under the project Assessing Impact of Increased Global Food Price on the Poor. Additional funding was provided by the African Agricultural Markets Programme, funded by DfID and the World Bank and implemented by the Common Market for Eastern and Southern Africa (COMESA), Michigan State University, and the International Food Policy Research Institute. The author would like to thank Patricia Bonnard of the Famine Early Warning Network (FEWS NET) project (funded by the United States Agency for International Development) and Steve Haggblade of Michigan State University for providing some of the price data used in the analysis, as well as Reno Dewina, research analyst with IFPRI, for general research and data analysis support. The author would also like to thank an anonymous reviewer for useful comments and suggestions.

ABBREVIATIONS AND ACRONYMS

ADF	Augmented Dickey-Fuller test: statistical test of whether a variable is stationary or non-stationary
ADMARC	Agricultural Development and Marketing Corportion: the state-owned agricultural marketing board of Malawi
CIF	cost, insurance, and freight: the cost of traded goods delivered to the port of destination, including the cost of sea freight and insurance
CPI	consumer price index: a number that measures the average price of goods and services in a country relative to the average price in some base period, used for calculating the rate of inflation
CV	Coefficient of variation: a measure of variability, calculated as the standard deviation divided by the mean.
ECM	Error correction model: a dynamic econometric model in which deviations from the long-run pattern influence the short-run changes in the dependent variable.
FAO	Food and Agriculture Organization of the United Nations
FOB	free on board: the cost of traded goods at the port of origin, excluding the cost of sea freight and insurance
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
SAFEX	South African Futures Exchange: a commodity exchange based in South Africa that organizes trading in futures of agricultural commodities such as maize
TAR	Treshhold auto-regression model: a model in which one variable influences another variable only if a threshold is passed.
VECM	Vector error-correction model: an error-correction model involving two or more dependent variables that influence each other.

1. INTRODUCTION

The global food crisis of 2007–2008 was characterized by a dramatic increase in the prices of agricultural commodities in international markets. Between January 2007 and March 2008, the food price index of the Food and Agriculture Organization (FAO) rose 61 percent. Staple food crop prices rose even more steeply: Over the same period, the prices of wheat and rice doubled, while that of maize increased by 42 percent. Since then, food prices have declined somewhat, but prices remain significantly higher than the average in 2006. For example, the average price of rice in 2009 is 90 percent higher than the average level in 2006 (FAO 2009b).

High world prices were transmitted to domestic markets, eroding the purchasing power of urban households and other net buyers of food, forcing them to reduce non-food spending and shift to cheaper foods. Poor urban households were particularly affected because they spend a large share of their income on food. At the national level, food-importing countries faced balance-of-payment pressure as the cost of food imports rose. In addition, the cost of operating food and nutrition programs at the national and international levels rose steeply. In dozens of countries, the high prices sparked demonstrations and sometimes riots. A number of countries, including Argentina, India, Russia, and Vietnam, responded by restricting rice and wheat exports in an attempt to keep domestic prices from rising. Finally, at the international level, food aid budgets were stretched, as increased need in developing countries coincided with decreased purchasing power of the World Food Programme and other food aid agencies (Benson et al. 2008).

The impact of the global food crisis may have been particularly severe in Sub-Saharan Africa for four reasons. First, the region is a net importer of food and agricultural commodities, so higher food prices lead to trade imbalances. Second, studies have shown that even in rural areas, a large percentage of households are net buyers of staple food crops, so they are hurt by higher food prices. Third, as a consequence of the low incomes in the region, food accounts for a large share of household budgets, often in the range of 50 to 70 percent. Finally, 34 of the 48 countries in the region are classified as "low income" by the World Bank, which limits their capacity to respond to the crisis (World Bank 2008a).

The goal of this report is to examine the impact of the global food crisis on Sub-Saharan African countries. In particular, this paper focuses on the degree to which changes in international grain prices are transmitted to domestic food markets in Sub-Saharan Africa. The degree of price transmission will be measured in two ways. First, we examine the historical increases in staple food prices in domestic markets in Sub-Saharan Africa during the period 2007–2008 and compare them to increases in the world prices for the same commodities. Second, we use time-series econometrics to examine the statistical relationship between world food prices and domestic food prices in nine African countries over a longer time period, at least five years.

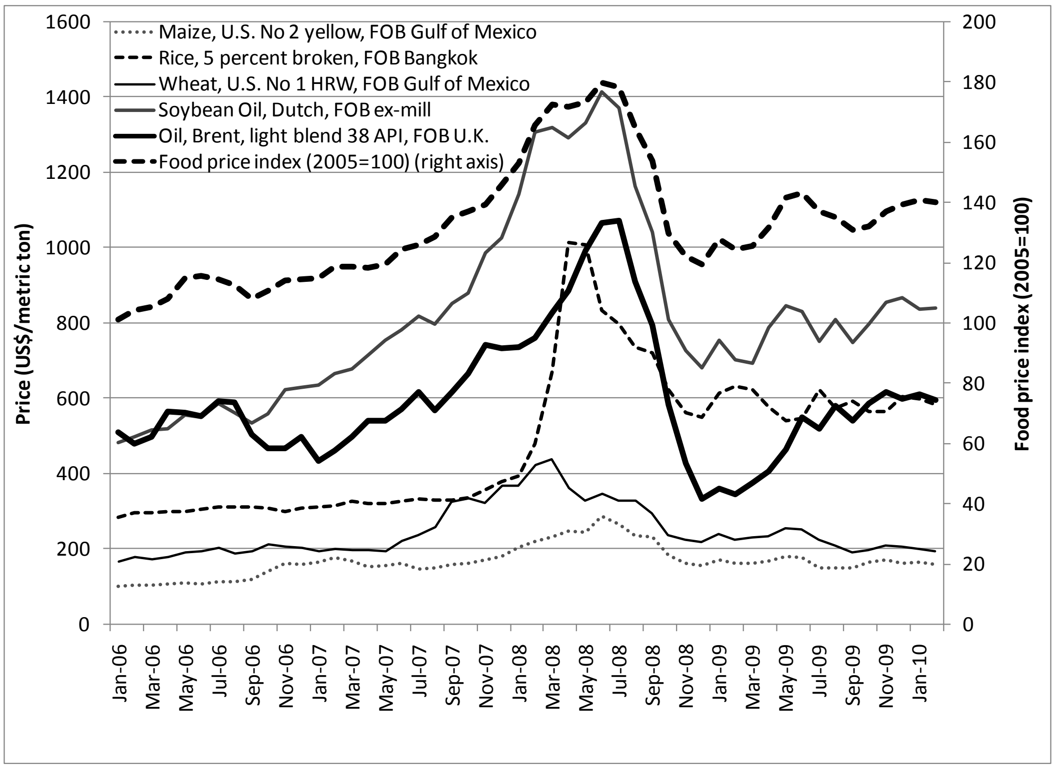
Section 2 provides a descriptive background of the causes and consequences of the global food crisis. Section 3 describes in more detail the data and methods used in this study. Section 4 presents the results of the analysis, and Section 5 summarizes and provides some discussion of the implications for policy and future research.

2. BACKGROUND

2.1. Trends in International Markets

As shown in Figure 1, the international prices of cereals and other food commodities rose sharply in 2007 and early 2008. Between January 2006 and early 2008, the world prices of maize, wheat, and soybeans more than doubled, and rice prices tripled. Since mid-2008, food prices have fallen, but most remain above the levels of 2006. For example, the prices of rice, maize, and soybean oil in February 2010 were at least 50 percent higher than in mid-2006.

Figure 1. Trends in commodity prices since 2006



Source: IMF 2010.
Note: 38 API is a measure of the density of the oil, on the scale of the American Petroleum Institute.

The sharp increases in food prices were catalyzed by various factors, including the rising cost of oil, biofuel subsidies in the United States and Europe, the depreciation of the U.S. dollar, export restrictions by some countries, and the imbalance between rapid growth in global income and slow yield growth. Speculation on futures markets has also been blamed for the increases. The relative importance of each factor is still debated among economists, but we can draw some preliminary conclusions.

The price of oil rose from around US$30[1] per barrel in 2003 to more than $140 per barrel in July 2008. This increased food prices by raising the cost of agricultural inputs (particularly fertilizer), irrigation, mechanized operations, and transportation. The impact was greatest where agriculture is heavily mechanized, including the industrialized countries, and where fertilizers are used intensively, including parts of Asia. In addition to increasing the cost of crop production, high oil prices make biofuels more profitable, diverting maize and oilseeds from food and feed markets. In 2008, almost 30 percent of the U.S. maize supply was used to supply ethanol processors. Studies by the Council of Economic

[1] All dollar amounts are in U.S. dollars.

Advisors and by the International Food Policy Research Institute (IFPRI) estimate that the growth of biofuel production explains about 33 to 39 percent of the rise in maize prices (Lazear 2008; Rosegrant 2008). By displacing acreage in wheat and soybeans, the growth in maize production for ethanol contributed to tight supplies and price increases in those markets as well.

Biofuels subsidies have created an additional link between food and fuel prices. Ethanol production in the United States is supported by biofuel mandates, a tax on imported ethanol, and a direct subsidy.[2] Although some ethanol production would be profitable at current oil prices without these policies, the import tariff and subsidies raise ethanol prices and production above what they would otherwise be, thus further increasing maize prices. Babcock (2008) estimated that removing all ethanol subsidies would reduce maize prices by 13 percent. This would represent roughly one-quarter of the price increase over 2007–2008 (Babcock 2008).

In addition, the U.S. dollar has fallen against the euro and other major currencies, causing the dollar-denominated prices of commodities to rise. If commodity prices had remained constant in euro terms from January 2006 to mid-2008, the dollar prices would have increased 31 percent. This implies that depreciation of the U.S. dollar explains 15 to 27 percent of the increase in dollar-denominated food prices over this period.

Finally, the trade policies of some major cereals exporters have played a role in the global food crisis. In late 2007 and early 2008, a number of exporters responded to rising food prices by restricting grain exports to keep prices low within their countries. Rice exports were restricted by Vietnam, India, and Egypt, among others, while wheat exports were limited by Argentina, Russia, Kazakhstan, and the Ukraine. By further limiting traded supplies, these restrictions have played a major role in the high price of rice and, to a lesser degree, wheat (von Braun et al. 2008).

However, these short-term "headline" causes would not have had the same dramatic effect on world markets if we had not experienced a 5- to 10-year period of disequilibrium, in which the growth in cereal demand outpaced the growth in cereal production. Cereal demand has been growing at two percent per year, thanks to rapid income growth in China, India, and more recently, Sub-Saharan Africa. As incomes rise, people diversify their diet and consume more meat and other animal products, increasing the demand for feed, particularly maize. Meanwhile, yield growth in these cereals has declined from a two to five percent range in the 1970s and 1980s to a range of one to two percent since the mid-1990s (World Bank 2008b). This decline can be attributed to the declining public investment in agricultural research and development, particularly in staple grains. This imbalance between grain supply and demand has been reflected in declining global stocks since 2000. At the beginning of the 2007–2008 crisis, the stock-to-use ratio for grains was 14 percent, the lowest ratio since FAO data collection began in 1960 (Schnepf 2008).

Many observers have blamed speculation, arguing that investors, looking for high returns, poured money into commodity futures markets in expectation of continued price increases, which in turn fueled the increase. Some economists are skeptical, however, arguing that these transactions involve offsetting purchases and sales, representing a "bet" on the future price without directly affecting the supply or demand of the commodity (Sanders, Irwin, and Merrin 2008). Rising futures prices could indirectly affect the price if they persuade farmers and processors that the price will rise, inducing them to increase stocks. However, as discussed above, grain stocks have been declining in recent years, not growing. Furthermore, prices have increased just as rapidly in commodities to which speculators do not have easy access, such as rice, durum wheat, edible beans, and fluid milk.[3] To date, the evidence that speculation on futures markets contributed to higher prices is weak.

If these factors explain the sharp rise in food prices over 2007 and early 2008, what explains the partial reversal of this trend since then? First, the agricultural sector responded to the high food prices by

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[2] The biofuels mandate establishes a minimum level of biofuel production each year, set at nine billion gallons in 2008. The tariff on imported ethanol is 54 cents per gallon plus 2.5 percent. The subsidy is in the form of a tax credit worth 51 cents per gallon.

[3] Edible beans and durum wheat do not have futures markets. Rice and fluid milk have futures markets, but it is more difficult to speculate in these commodities because they are not included in the main commodity indexes.

expanding output. The global cereal harvest in 2008 was a record 2.3 billion tons, seven percent higher than the 2007 cereal harvest (FAO 2009a). Second, the price of oil peaked at around $140 per barrel in June and July 2008 and began to fall sharply in August as the global recession dampened the demand. By the end of that year, oil had fallen to $41 per barrel, reducing the demand for ethanol and other biofuels. Third, grain-exporting countries removed or relaxed their export restrictions. As a result, the international price of wheat began to decline in April 2008, rice in June, and maize in July.

It may be premature to declare the global food crisis over, however. The average prices of maize, soybeans, and rice in early 2010 are still 48 to 92 percent higher than in mid-2006, in spite of the global recession. Furthermore, oil prices have rebounded to around $75 per barrel. As the global economy emerges from recession, we can expect the demand for oil to rise rapidly and the demand for food to rise more modestly, both of which will contribute to higher food prices.

2.2. Transmission of World Prices to Domestic Markets

The first objective of this report is to measure the degree to which changes in world food prices are transmitted to domestic markets in Sub-Saharan Africa. Fluctuations in world food prices will affect people in developing countries only if the price changes are transmitted to domestic markets in those countries. In this section we provide a conceptual framework of the conditions under which world prices are transmitted to local markets and a summary of previous work on this topic. This background will be useful in interpreting the results of the analysis of price transmission from world markets to markets in Sub-Saharan Africa, which will be presented in Section 4.

Conceptual Framework

Price transmission refers to the effect of prices in one market on prices in another market. It is generally measured in terms of the transmission elasticity, defined as the percentage change in the price in one market given a one percent change in the price in another market. Although the markets could be for related commodities (such as maize and soybeans) or for products at different points in the supply chain (for example, wheat and bread), we focus on the case of markets for the same commodity in two locations. We start with the simple case in which markets are perfectly competitive:

- The product is homogeneous, meaning there is no variation in quality;
- Traders are numerous and small so that none of them has market power;
- Traders have perfect information;
- Trading occurs instantly;
- There are no trade taxes or other policy barriers to trade; and
- There are no transportation or transaction costs.

In this case, spatial arbitrage would ensure that the price of a commodity is the same in all markets. If the price in market A (P_A) exceeded the price in market B (P_B), it would be profitable to ship the product from market B to market A until the prices were equal again. Price transmission would be "perfect" in that any price change in one market would be quickly reflected in an equivalent change in other markets. In other words, the transmission elasticity would be 1.0.

In real life, of course, these assumptions often do not hold which reduces or slows the transmission of prices from one market to another. Below, we explore the implications of relaxing each of these assumptions.

Homogeneous product: If local and imported goods are considered the same by consumers (perfect substitutes), it is not possible for a vendor to charge different prices depending on the origin of the product, so the prices of local and imported goods will be the same. Often, however, there are perceived quality differences between commodities produced in different locations. If so, local and imported goods may be imperfect substitutes and the prices will differ between them. Furthermore, the prices will move together to some degree, but price transmission will not be perfect.

Small and numerous traders: If a small number of traders dominate the market, they may be able to exert market power. For example, if the import market is dominated by a few large traders, they may be quick to transmit price increases in world markets but slow to pass on price reductions.

Perfect information: If traders do not have up-to-date information about prices in other markets, they cannot respond quickly to profitable opportunities. This will impede the process of spatial arbitrage that transmits price changes from one market to another.

Trading occurs instantly: In practice, it often takes more than a month from the time a trader decides to import grain from overseas to the availability of the imported commodity in domestic markets, particularly in landlocked countries. Because of this, the process of spatial arbitrage can be slow and price differences may persist over time before being corrected.

No policy barriers to trade: Government restrictions on internal trade are no longer prevalent in Sub-Saharan Africa, but restrictions on international trade are common. Tariffs increase the cost of transporting goods across national borders, but they do not reduce price transmission unless they choke off all trade in the commodity. Quantitative barriers, if binding, will break the transmission of prices from one market to another. If government licenses are required to trade or if there are obstacles to purchasing foreign exchange, trader response to changes in international prices may be delayed or blocked entirely by administrative procedures, resulting in imperfect price transmission. Finally, sporadic intervention by the government to close borders, undertake government-sponsored imports, or change trade policy can greatly increase the commercial risk in international trade. This will discourage traders from participating in international trade, raise the risk premium associated with trade, and reduce price transmission.

No transportation or transaction costs: Transportation costs are a major factor in trade, particularly for staple foodcrops. A low value-to-bulk ratio[4] implies that transportation costs are large relative to the cost of the product. For imported grain crops in Sub-Saharan Africa, the cost of sea freight and overland transportation may represent more than half the final price. How does this affect spatial arbitrage and price transmission? It depends on the autarky price in each market, that is, the prices that would prevail in the absence of trade.

If the difference between the autarky price in market A (P_A^a) and in market B (P_B^a) is *greater* than the full cost of transportation between the two markets (c), including taxes, risk premiums, and normal profits, then trade will be profitable. In other words, if

$$P_B{}^a - P_A{}^a > c, \tag{1}$$

then it will be profitable to ship the commodity from market A to market B. Trade will reduce the supply and raise the price in the exporting market (market A) and increase the supply and reduce the price in the importing market (market B), thus causing the prices in the two markets (P_A and P_B) to move toward each other. Equilibrium is reached when

$$P_B - P_A = c, \tag{2}$$

Where:

$$P_B \leq P_B{}^a \text{ and } P_A \geq P_A{}^a. \tag{3}$$

In this situation, any small change in the price in one market would be reflected in an equivalent change in the price in the other market. This implies that prices would move together.

Even if the absolute difference between two prices remains constant, however, this does not imply a transmission elasticity of 1.0. This is because if two prices change by the same *absolute* amount, the *percentage* increase will be greater for the lower of the two prices. For example, if the world price of rice is $300 per ton and the domestic price of rice in Ghana is $600 per ton, and a $60 per ton increase in

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[4] The value-to-bulk ratio can be defined in terms of the monetary value per ton or the monetary value per cubic meter of the product. Since transportation costs are generally proportional to bulk (weight, volume, or both), the cost of transporting will be a larger percentage of the final value for a good with a low value-to-bulk ratio (such as maize) than for a good with a high value-to-bulk ratio (such manufactured goods).

the world price results in a \$60 per ton increase in the local price, the elasticity of price transmission from the world price to the domestic price would be 0.5.[5] Conversely, for an export commodity where the domestic price is lower than the world price, the transmission elasticity could be greater than 1.0.

On the other hand, if the difference between the autarky price in market A and in market B is *less* than the full cost of transportation, then it is not profitable to trade between the two regions. Trade will remain unprofitable if prices remain in the following ranges:

$$P_A + c > P_B > P_A - c \quad , \tag{4}$$

which implies that

$$P_B + c > P_A > P_B - c \quad . \tag{5}$$

In this simple two-region, one-commodity model, as long as there is no trade, there will be no price transmission.[6] If the cost of transportation (c) is large, this will create a large band within which each price can fluctuate without inducing trade and reconnecting the two prices. The full cost of transportation will be greater if (1) the distance between the two markets is great, (2) transportation infrastructure is poor, (3) tariffs and other trade taxes are high, (4) trading is particularly risky, or (5) some combination of these factors is in play.

If the direction of trade between the two markets reverses on a regular basis, price transmission will be imperfect. Trade reversals are not uncommon in agricultural markets because the supply of most crops is seasonal, so a region may export a crop during its harvest season and import it during the off-season. When the good is being transported from A to B, the price in market B will be greater, and when the flow is reversed, the price in market A will be greater. In this case, the relationship between the two prices may not be obvious, even if there is regular trade between the two markets.

Until this point, we have assumed that market A and market B are symmetric, in that each market influences prices in the other market. However, in the relationship between world market prices and domestic prices in Sub-Saharan Africa, there is a large difference in scale. We can usually adopt the "small country assumption" that domestic prices will not have a noticeable effect on world commodity prices, but world prices can influence domestic prices. For example, Côte d'Ivoire is one of the larger rice importers in Sub-Saharan Africa, but its imports of 10,000 tons per year represent just 0.04 percent of the 25 million tons of rice traded on world markets. Thus, it is unlikely that changes in Ivorian prices or import volumes will have any measurable impact on world rice prices. Similarly, although South Africa exported 1.0 million tons of maize in 2006, this was barely 1 percent of the 95 million tons of maize traded globally that year (FAO 2009a).

Thus, in the absence of trade barriers, world food prices establish upper and lower bounds for domestic food prices:

$$P_W + c \geq P_A \geq P_W - c \quad , \tag{6}$$

where P_W is the world price, P_A is the wholesale price in an African city, and c is the full cost of transportation between the world market and the domestic market. In this equation, $P_W + c$ is the import parity price, the full cost of importing the commodity from world markets. Similarly, $P_W - c$ is the export parity price, the net price of exporting at the world price after deducting transportation costs. As described above, a large transportation cost (c) implies a large band around the world price within which the domestic price may vary with no international trade and hence no price transmission. We expect price transmission to be higher when the domestic price is near the import parity price, implying at least occasional imports, or when the domestic price is near the export parity price, implying at least occasional exports. We expect little or no price transmission when the domestic price is well within the bounds set by the import parity and export parity prices. We also expect more limited price transmission when there

[5] The elasticity is calculated as follows: (60/600)/(60/300) = 0.5.

[6] In a multiple-commodity system, price transmission may occur through a substitute commodity that is traded, even if the commodity in question is not.

are policy barriers to international trade, lack of market information, or uncompetitive markets.

Previous Research on Price Transmission

Research on price transmission has been motivated largely by the belief that co-movement of prices in different markets can be interpreted as a sign of efficient, competitive markets, while lack of co-movement is an indication of market failures, including lack of information, poor infrastructure, or uncompetitive markets. A large number of studies examine the degree of price transmission between markets within a country, including several for Sub-Saharan Africa (see Abdulai 2000 for Ghana; Rashid 2004 for Uganda; Lutz, Kuiper, and van Tilburg 2006 for Benin; Negassa and Myers 2007 for Ethiopia; Van Campenhout 2007 for Tanzania; Myers 2008 for Malawi; and Moser, Barrett, and Minten 2009 for Madagascar). Here, we focus on methodological advances and the empirical studies that examine the transmission of prices from the world market to domestic African markets.

Early studies of price transmission used simple correlation coefficients of contemporaneous prices. A high correlation coefficient is evidence of co-movement and was often interpreted as a sign of an efficient market. Another early approach was to use regression analysis on contemporaneous prices, with the regression coefficient being a measure of the co-movement of prices. For example, Mundlak and Larson (1992) estimated the transmission of world food prices to domestic prices in 58 countries using annual price data from the FAO. They found very high rates of price transmission: The median elasticity of transmission was 0.95, implying that 95 percent of any change in world markets was transmitted to domestic markets.

The static regression approach has been criticized for assuming instantaneous response in each market to changes in other markets. In fact, there is generally a lag between the price change in one market and the impact on another market due to the time it takes traders to notice the change and respond to it. A change in world prices may take more than a month to be reflected in domestic prices. These dynamic effects can be captured by including lagged world prices as explanatory variables in the regression analysis (Ravallion 1986).

In the 1980s, researchers became aware of the problem of nonstationarity. Standard regression analysis assumes that the mean and variance of the variables are constant over time. This implies that the variable tends to return toward its mean value, so the best estimate of the future value of a variable is its mean value. However, in the analysis of time-series data, prices and many other variables are often nonstationary, meaning that they drift randomly rather than tending to return to a mean value. One implication of this "random walk" behavior is that the best estimate of the future price is the current price. When standard regression analysis is carried out with nonstationary variables, the estimated coefficients are unbiased but the distribution of the error is non-normal, so the usual tests of statistical significance are invalid. In fact, with a large enough sample, any pair of nonstationary variables will appear to have a statistically significant relationship, even if they are actually unrelated to each other (Granger and Newbold 1974; Phillips 1987).

However, the first difference ($\Delta x = x_t - x_{t-1}$) of a nonstationary variable may be stationary. If so, the original variable (x_t) is said to be integrated to degree 1 or I (1). Because the first difference is stationary, it can be estimated econometrically without the problems described above. Furthermore, two nonstationary variables may be related to each other by a long-term relationship even if they diverge in the short run. If two nonstationary variables move together in the long run, they are said to be cointegrated.[7] In this case, an error correction model (ECM) is appropriate to deal with the problems of dynamic effects and nonstationarity, as discussed below (Engle and Granger 1987).

Using an inappropriate method can have dramatic effects on the results. For example, Quiroz and Soto (1995) repeated the analysis of Mundlak and Larson (1992) with similar data but using the error correction model. Where Mundlak and Larson found an average of 95 percent price transmission, Quiroz

[7] In technical terms, cointegration refers to the situation in which a linear combination of nonstationary variables yields a stationary variable, for example $P_A - \beta P_B = \varepsilon$, where P_A and P_B are nonstationary variables, β is a coefficient, and ε is a stationary error term.

and Soto found no relationship between domestic and international prices for 30 of the 78 countries examined. Even in countries with a relationship, the convergence was very slow in many of them.

Conforti (2004) examined price transmission in 16 countries, including 3 in Sub-Saharan Africa, using the error correction model. In Ethiopia, he found statistically significant long-run relationships between world and local prices in four out of seven cases, including retail prices of wheat, sorghum, and maize. In Ghana, there was a long-run relationship between international and local wheat prices but no such relationship for maize and sorghum. And in Senegal, he found a long-run relationship in the case of rice but not maize. In general, the degree of price transmission in the Sub-Saharan African countries was less than in the Asian and Latin-American countries.

Even statistical models that take nonstationarity into account face another problem. The lack of price integration does not necessarily imply inefficient markets or policy barriers to trade. As pointed out by Harriss (1979), Baulch (1997), and Barrett and Li (2002), transport costs create a range over which a given price is not affected by the price in another market. For example, if the domestic price lies between the import parity price and the export parity price, it will not show any co-movement with international prices even if markets are efficient and there are no policy barriers to trade. One econometric approach to deal with this situation is threshold autoregressive (TAR) models (Balke and Fomby 1997; Hansen and Seo 2002). In one version of these models, two variables have no relationship with each other when the difference between them is below a certain threshold, but they become linked when the difference exceeds that threshold (Van Campenhout 2007; Myers 2008).

3. DATA AND METHODS

This analysis uses monthly data on prices in international markets and nine Sub-Saharan African countries to examine the transmission of world prices to domestic markets in the region. The data and methods for this component of the analysis are described in sections 3.1 and 3.2, respectively.

3.1. Price Data

The descriptive analysis of price trends over 2007–2008 uses 83 monthly price series for staple foodcrops from 12 countries in Sub-Saharan Africa, compiled by FAO (2009b). These prices have already been converted to U.S. dollars per ton.

The econometric analysis of price transmission uses a somewhat smaller set of staple food prices because the analysis requires a longer series of continuous monthly data. For this analysis, we use the international prices shown in Table A.1and 62 price series from nine Sub-Saharan African countries shown in Table A.2. (both tables are in Appendix A). The selection of data followed certain criteria to ensure quality and minimum sample size. In particular, each price series came from a single source (we did not combine data from multiple sources for an individual price series). In addition, we limited ourselves to prices series that included at least 40 months of data. Third, we did not use any series that had more than two missing values in a row. Individual missing values were filled in using linear interpolation.

In addition, exchange rates for each of the nine African countries were obtained from the international financial statistics database maintained by the International Monetary Fund (IMF 2009). The IMF exchange rates were used to convert all African prices to current U.S. dollar prices. The U.S. dollar equivalent of the African domestic prices and the U.S. dollar world prices were converted to real U.S. dollars at 2008 prices using the U.S. consumer price index (CPI), obtained from the Bureau of Labor Statistics.

3.2. Analysis of Price Transmission

This study uses the vector error correction model (VECM) to examine the relationship between world food prices and domestic food prices in African countries. Each estimated model consists of a domestic price for one commodity in one market in Sub-Saharan Africa and the world market price for the same commodity. The VECM is appropriate if two conditions are met:

1. Each variable is nonstationary and integrated to degree 1, written as I(1). This means that the variable follows a random walk, but the first difference (X_t - X_{t-1}) is stationary, written as I(0).
2. The variables are cointegrated, meaning that there is a linear combination of the variables that is stationary. We are analyzing two prices at a time, so that the cointegrating equation would take the form of $P_1 = \alpha + \beta P_2 + \varepsilon$ or $P_1 - \alpha - \beta P_2 = \varepsilon$, where ε is stationary.

For each pair of domestic and world prices, the analysis consists of three steps:

1. We test the price variables individually to see if they are I(1). This is done with the augmented Dickey-Fuller test and the Phillips-Perron test.
2. We use the Johansen test to determine whether the two series are cointegrated, meaning that each variable is I(1) and a linear combination of the two variables is I(0). In terms of our analysis, this tests whether there is a long-run relationship between the domestic price and the corresponding world price.
3. If the Johansen test indicates that there is a long-run relationship between the two variables, then we estimate the VECM. The model takes the following general form:

$$\Delta p_t = \alpha + \Pi p_{t-1} + \sum_{k=1}^{q} \Gamma_k \Delta p_{t-k} + \varepsilon_t, \quad (7) \qquad (7)$$

where $\mathbf{p_t}$ is an *n* x 1 vector of *n* price variables;
Δ is the difference operator, so $\Delta\mathbf{p_t} = \mathbf{p_t} - \mathbf{p_{t-1}}$;
$\boldsymbol{\varepsilon}_t$ is an *n* x 1 vector of error terms;
$\boldsymbol{\alpha}$ is an *n* x 1 vector of estimated parameters that describe the trend component;
$\boldsymbol{\Pi}$ is an *n* x *n* matrix of estimated parameters that describe the long-term relationship and the error correction adjustment; and
$\boldsymbol{\Gamma}_k$ is a set of *n* x *n* matrices of estimated parameters that describe the short-run relationship between prices, one for each of *q* lags included in the model.

The VECM tests for the effect of each variable on each other variable. In the context of this study, the two-variable VECM tests the effect of world prices on domestic prices as well as the effect of domestic prices on world prices. Since most countries (and all Sub-Saharan African countries) may be considered "small countries" in the staple foodcrop markets, there is little value in testing the effect of domestic prices on world prices. In addition, tests indicate that one lagged term is generally sufficient. For our purposes, then, we are interested in only one portion of the VECM. This portion can be simplified as follows:

$$\Delta \mathrm{p}_{\mathrm{t}}^{\mathrm{d}} = \alpha + \theta\left(p_{t-1}^{d} - \beta p_{t-1}^{w}\right) + \delta\Delta \mathrm{p}_{\mathrm{t-1}}^{\mathrm{w}} + \rho\Delta p_{t-1}^{d} + \varepsilon_t, \qquad (8)$$

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

As described above, if the original price series are I(1), then the first differences (Δp) will be stationary, or I(0). The coefficients in the error correction model can be interpreted as follows:

1. Since the prices are expressed in logarithms, the cointegration factor (β) is the long-run elasticity of the domestic price with respect to the international price. Thus, β is the long-run elasticity of price transmission. The expected value for imported commodities is $1 > \beta > 0$, but for exports, it may be greater than 1. Thus, if $\beta = 0.5$, this implies that 50 percent of the proportional change in the international price will be transmitted to the domestic price in the long run.
2. The error correction coefficient (θ) reflects the speed of adjustment. We expect it to fall in the range of $-1 < \theta < 0$. The term in parentheses represents the deviation or "error" between the prices in the previous period and the long-run relationship between the two prices. If the error is positive (the domestic price is too high given the long-term relationship), then the negative value of θ helps "correct" the error by making it more likely that the Δp^d_t is negative. The larger θ is in absolute value (that is, the closer to -1), the more quickly the domestic price (p^d) will return to the value consistent with its long-run relationship to the world price (p^w).
3. The coefficient on change in the world price (δ) is the short-run elasticity of the domestic price relative to the world price. In this case, it represents the percentage adjustment of domestic price one period after a one percent shock in international price. The expected value is $0 < \delta < \beta$.
4. The coefficient on the lagged change in the domestic price (ρ) is the autoregressive term, reflecting the effect of each change in the domestic price on the change in domestic price in the next period. The expected value is $-1 < \rho < 1$.

Testing for Granger causality plays an important part in many vector error correction models, but it is less important when examining the transmission of international prices to domestic prices. This is because causality from domestic to international prices is implausible.

4. RESULTS

The results are divided into two parts. Section 4.1 examines the trends in 83 staple food prices in 12 countries of Sub-Saharan Africa during the global food crisis of 2007–2008. Section 4.2 uses time-series econometrics to analyze the relationship between domestic and international prices in the longer term for 62 prices in 9 African countries.

4.1. Trends in Staple Food Prices in Sub-Saharan Africa

In this section, we examine the change in staple food prices (converted to U.S. dollars) between June 2007 and June 2008 for 83 prices across 12 countries in Sub-Saharan Africa: Cameroon, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Senegal, South Africa, Tanzania, Uganda, and Zambia. We use this time period because it represents the period of rapid growth in world food prices. The international price of maize peaked in June 2008, rice in May 2008, and wheat in March 2008.[8]

Table 1 shows the change in staple food prices in 22 markets of eastern Africa. The African price increases are measured in U.S. dollars in order to adjust for domestic inflation and allow comparison with the increase in international prices. The first column of figures indicates that food prices in eastern Africa have increased significantly during this period. The average increase in dollar terms was 76 percent, but there is a wide range across countries. In Ethiopia, food price increases were particularly high, ranging from 83 percent to 184 percent across the 6 markets. Food price increases were somewhat lower in the other countries. The range is from 19 percent to 100 percent, but most of the increases are between 40 percent and 65 percent.

The second column of figures indicates the change in domestic prices as a percentage of the change in the corresponding international prices. Thus, 100 percent would indicate that domestic and international prices changed in the same proportion between June 2007 and June 2008. For maize, rice, and wheat, there are corresponding international prices. For beans and teff, we compare the domestic price increase to the simple average increase in the international prices of maize, rice, and wheat.

Table 1 indicates that Ethiopian food prices increased more rapidly than world food prices over the reference period. Since there is very little commercial trade in the main staple grains in Ethiopia, it is difficult to understand how international food prices would be directly transmitted to local markets. One possible explanation is that Ethiopia has experienced rising inflation in the past two years. Although this would normally be accompanied by a depreciation of the currency, the government has imposed restrictions on imports and on the purchase of foreign exchange, thus suppressing the depreciation. From June 2007 to June 2008, domestic prices rose about 70 percent but the exchange rate remained essentially unchanged. In addition, a supply shock may have contributed to higher real prices (see World Bank, 2007; and Loening, Durevall, and Birru 2008).

[8] These world prices refer to U.S. No 2 yellow maize FOB Gulf of Mexico, Thai Super A1 broken white rice FOB Bangkok, and U.S. No 2 hard red winter wheat FOB Gulf of Mexico.

Table 1. Changes in eastern African food prices from June 2007 to June 2008

Country	Market	Commodity	Type of market	Increase in domestic price converted to US$	Increase in domestic price as a pct of the increase in world price
Ethiopia	Addis Addis	Maize	Wholesale	184%	236%
	Addis Addis	Teff	Wholesale	100%	111%
	Addis Addis	Wheat	Wholesale	83%	141%
	Addis Addis	White sorghum	Wholesale	121%	175%
	Jimma	Wheat	Wholesale	92%	156%
	Mekele	Wheat	Wholesale	132%	224%
Kenya	Busia	Beans	Wholesale	100%	112%
	Busia	Maize	Wholesale	62%	80%
	Eldoret	Beans	Wholesale	23%	26%
	Eldoret	Maize	Wholesale	55%	71%
	Kisumu	Beans	Wholesale	19%	21%
	Kisumu	Maize	Wholesale	56%	71%
	Mombasa	Beans	Wholesale	54%	60%
	Mombasa	Maize	Wholesale	74%	95%
	Nairobi	Beans	Wholesale	54%	60%
	Nairobi	Maize	Wholesale	71%	91%
Rwanda	Kigali	Beans	Wholesale	36%	40%
	Kigali	Maize	Wholesale	63%	81%
	Kigali	Rice	Wholesale	64%	42%
Tanzania	Dar es Salaam	Beans	Wholesale	54%	60%
	Dar es Salaam	Maize	Wholesale	99%	127%
	Dar es Salaam	Rice	Wholesale	71%	47%
Average				76%	97%

Source: Authors' calculations based on price data from FAO (2009b and 2009c).
Note: For teff and beans, the last column compares the domestic price increase to the average increase in the world price of maize, rice, and wheat over the same time period.

In the other eastern African countries, the proportional change in domestic prices was less than the proportional change in the corresponding international price. The percentages appear to be lower for beans than for maize and rice, perhaps reflecting the fact that beans are a nontradable commodity.

Food prices followed a similar pattern in southern Africa (see Table 2). Across the 21 prices examined, the average increase (in dollar terms) between June 2007 and June 2008 was 107 percent. The highest price increases were in Malawi: Six of the nine prices examined in the country increased by more than 150 percent. Cassava and rice prices seemed to rise less than maize prices. In Mzuzu, the main market in the cassava-growing region of Malawi, cassava prices actually decreased over the year.

In Mozambique and Zambia, staple food prices increased 40 to 60 percent, significantly less than in Malawi. This difference is somewhat surprising given that Malawi lies between the other two countries, so one would expect co-movement of prices in the three countries, at least for markets near the borders. In the second quarter of 2008, responding to the high food prices, Malawi, Zambia, and Tanzania all banned the export of maize (Banda 2008), which would delink prices in neighboring countries.

The smallest price increases, however, were in South Africa. Yellow and white maize prices rose less than 10 percent in dollar terms between June 2007 and June 2008, while wheat prices increased just 32 percent. There were no unusual movements in the rand-dollar exchange rate that would explain this low rate of increase in food prices. South Africa is a major regional exporter of maize, exporting 470,000 tons of maize in 2007–2008. It is not clear why South African maize and wheat prices remained so stable during this period, though export restrictions would help to explain this pattern.

Table 2. Changes in southern African food prices from June 2007 to June 2008

Country	Market	Commodity	Type of market	Increase in domestic price converted to US$	Increase in domestic price as a pct of the increase in world price
Malawi	Lilongwe	Maize	Retail	171%	219%
	Lilongwe	Rice	Retail	53%	35%
	Liwonde	Maize	Retail	164%	210%
	Lizulu	Maize	Retail	244%	313%
	Mzimba	Maize	Retail	174%	223%
	Mzuzu	Cassava	Retail	-2%	-2%
	Mzuzu	Maize	Retail	156%	200%
	Mzuzu	Rice	Retail	29%	19%
	Nsanje	Maize	Retail	159%	203%
Mozambique	Maputo	Maize	Retail	62%	79%
	Maputo	Rice	Retail	54%	35%
	Nampula	Cassava	Retail	36%	40%
	Nampula	Maize	Retail	123%	158%
South Africa	Johannesburg	Wheat	Wholesale	32%	54%
	Johannesburg	White maize	Wholesale	7%	9%
	Johannesburg	Yellow maize	Wholesale	9%	12%
Zambia	National avg	Maize	Retail	57%	73%
	National avg	Maize flour	Retail	56%	72%
	National avg	Wheat flour	Retail	43%	73%
Average				86%	107%

Source: Authors' calculations based on price data from FAO (2009b and 2009c).
Note: For cassava, the last column compares the domestic price increase to the average increase in the world price of maize, rice, and wheat over the same time period.

In western Africa, the food prices appear to have increased somewhat less than in southern and eastern Africa (see Table 3). Across the 42 prices examined, the average increase over the period from June 2007 to June 2008 was 42 percent, compared to 76 percent in eastern Africa and 86 percent in southern Africa. Although the number of cases is too small to draw firm conclusions, the price increases for cassava, plantains, and beans are generally low, less than 15 percent. In contrast, the price increases for rice and maize tend to be in the range of 40 to 80 percent. The results show some interesting contrasts. For example, the price of rice increased just 4 percent in Accra (Ghana) but rose 132 percent in Dakar (Senegal). Similarly, maize prices increased more than 80 percent in Accra but less than 20 percent in several markets in Cameroon. Rice is imported in significant volumes by most western African countries, so it is likely that differences in import policy play an important role in the variation in rice price trends across the region. Maize imports tend to be small relative to domestic production, so variation in domestic production would contribute to differences in maize price trends. In addition, several western African countries imposed grain export bans, which raised prices in landlocked countries and caused differences in price trends across countries (Staatz et al. 2008).

The last column of figures shows the increase in domestic prices as a percentage of the increase in world prices. On average, the increase in domestic prices was 42 percent of the increase in the corresponding world prices. In most cases, the percentage was less than 60 percent. One notable exception is the price of maize in Accra, which was slightly greater (105 percent) than the increase in maize prices on the world market over the same period.

Table 3. Changes in western African food prices from June 2007 to June 2008

Country	Market	Commodity	Type of market	Increase in domestic price converted to US$	Increase in domestic price as a pct of the increase in world price
Cameroon	Bafoussam	Cassava	Retail	3%	3%
	Bafoussam	Maize	Retail	10%	13%
	Bafoussam	Plantains	Retail	4%	4%
	Bafoussam	Red beans	Retail	11%	12%
	Bafoussam	Rice	Retail	63%	41%
	Bafoussam	Wheat flour	Retail	46%	78%
	Bamenda	Maize	Retail	15%	19%
	Bamenda	Rice	Retail	92%	60%
	Doula	Maize	Retail	35%	45%
	Doula	Rice	Retail	51%	33%
	Garoua	Maize	Retail	54%	70%
	Garoua	Rice	Retail	46%	30%
	Yaounde	Cassava	Retail	14%	16%
	Yaounde	Maize	Retail	22%	29%
	Yaounde	Plantains	Retail	13%	14%
	Yaounde	Red beans	Retail	15%	17%
	Yaounde	Rice	Retail	54%	36%
	Yaounde	White flour	Retail	30%	51%
Ghana	Accra	Cassava	Retail	8%	9%
	Accra	Maize	Retail	82%	105%
	Accra	Rice	Retail	45%	3%
Mali	Bamako	Millet	Wholesale	52%	75%
	Bamako	Rice	Wholesale	71%	46%
	Kayes	Millet	Wholesale	36%	52%
	Kayes	Rice	Wholesale	61%	40%
	Dakar	Millet	Retail	41%	59%
	Dakar	Rice	Retail	132%	87%
	Dakar	Sorghum	Retail	29%	42%
	Diourbel	Rice	Retail	85%	56%
	Fatick	Rice	Retail	87%	57%
	Kaolack	Rice	Retail	72%	47%
	Kolda	Rice	Retail	57%	37%
	Louga	Rice	Retail	56%	37%
	Matam	Millet	Retail	45%	65%
	Matam	Rice	Retail	58%	38%

Table 3. Continued

Country	Market	Commodity	Type of market	Increase in domestic price converted to US$	Increase in domestic price as a pct of the increase in world price
	Matam	Sorghum	Retail	32%	46%
	Saint Louis	Millet	Retail	41%	59%
	Saint Louis	Rice	Retail	31%	20%
	Saint Louis	Sorghun	Retail	41%	59%
	Tambacounda	Rice	Retail	54%	35%
	Thies	Rice	Retail	83%	54%
	Zquinchor	Rice	Retail	67%	44%
Average				45%	42%

Source: Authors' calculations based on price data from FAO (2009b and 2009c).
Note: For millet, beans, cassava, and plantains, the last column compares the domestic price increase to the average increase in the world price of maize, rice, and wheat over the same time period.

The trends in staple food prices over 2007–2008 are summarized in Table 4 and Table 5. According to Table 4, the average price increase across the 83 markets examined was 63 percent, which is 71 percent of the price increase of the corresponding commodities in world markets. As discussed above, Malawi and Ethiopia experienced the sharpest increases in staple foodcrop prices over the reference period. In both cases, the average price increase was more than 100 percent, and in both cases the rise in domestic prices surpassed that in world prices for corresponding commodities. The countries with the lowest average price increase were South Africa (25 percent), Cameroon (32 percent), and Ghana (39 percent).

Table 4. Summary of food price increases by country

Country	NBR of price series	Increase in domestic price (in US$)	Increase in domestic price as a pct of the increase in world price
Cameroon	18	32%	32%
Ethiopia	6	119%	174%
Ghana	3	32%	39%
Kenya	10	57%	69%
Malawi	9	127%	158%
Mali	4	55%	53%
Mozambique	4	69%	78%
Rwanda	3	54%	54%
Senegal	17	60%	50%
South Africa	3	16%	25%
Tanzania	3	75%	78%
Zambia	3	52%	73%
Average or total	83	63%	71%

Source: Author's calculation based on price data from FAO (2009b and 2009c)

It is interesting to note that the food price increases appear to be greater in landlocked countries than in coastal countries. All the landlocked countries except Rwanda and Mali experienced staple food price increases greater than the average (71 percent), while all coastal countries except Mozambique had food price increases below this average. Landlocked countries face higher transportation costs from the ports, so imported foodcrops will have higher prices in landlocked countries, and food prices may fluctuate more widely because of the larger gap between export parity and import parity prices. But an increase in the world price should have the same absolute effect on the price of an imported food staple in both types of countries, and the percentage increase could well be smaller in the landlocked country because of the higher initial price.

Of course, the spike in world food prices was accompanied by a similar increase in oil and other fuel costs. Thus, one possible explanation is that landlocked countries face both higher cost, insurance, and freight (CIF) prices of imported food and higher costs of overland transport. Grain export bans imposed by several African countries would also exacerbate the price spike in landlocked countries.

Table 5 summarizes the same price data by commodity. Based on our sample of 83 markets in Sub-Saharan Africa and our reference period (June 2007 to June 2008), the largest increases in domestic food prices occurred in maize (87 percent), wheat (65 percent), and rice (62 percent). The smallest increases occurred in plantains (9 percent), cassava (12 percent), and beans (41 percent). This is not surprising, given that rice and wheat (and maize to a lesser degree) are the most tradable of the staple food commodities. In contrast, plantains, cassava, and beans are generally not traded internationally, though there is some cross-border trade among African countries. Thus, it is likely that the impact of the global food crisis influenced African countries directly through the price of imported wheat, rice, and (in some countries) maize. This would motivate consumers to shift away from these crops to nontradable food staples, thus indirectly pushing up the price of these substitutes. Because the nontradable staples are imperfect substitutes for the internationally traded staples, the price increase of the former was less than that of the latter.

Table 5. Summary of food price increases by commodity

Commodity	NBR of price series	Increase in domestic price (in US$)	Increase in domestic price as a pct of the increase in world price
Beans	9	41%	45%
Cassava	5	12%	13%
Maize	26	87%	112%
Millet	5	43%	62%
Plantains	2	9%	9%
Rice	24	62%	41%
Sorghum	4	56%	81%
Wheat	7	65%	111%
Average	83	63%	71%

Source: Author's calculation based on price data from FAO (2009b and 2009c)

These results should be interpreted with some caution, however. We have only a few price series available for some countries (such as three each for Ghana, Rwanda, South Africa, Tanzania, and Zambia) and for some commodities (for example, less than five each for plantains and sorghum).

A bigger issue with this type of analysis is that we have compared domestic and international food price trends for one, rather exceptional, 12-month period. It is possible that the high domestic food prices were the result of poor weather and below-average harvests in a number of key countries. Alternatively, it is possible that world prices are transmitted when they change dramatically but not under more normal conditions that prevail in the long term. For this reason, we complement the descriptive analysis of price trends with an econometric analysis of the long-term relationship between domestic prices of staple foodcrops and the world price of the corresponding commodity.

4.2. Econometric Analysis of Price Transmission

This section describes the econometric analysis of the relationship between international and domestic prices using monthly data on 62 staple food prices in nine Sub-Saharan African countries over 5 to 10 years. For each domestic price, we estimate a vector error correction model (VECM) that combines a food price from Sub-Saharan Africa (converted to U.S. dollars) and the international price of the same commodity.

Before presenting the econometric results, however, it is useful to examine the descriptive statistics of the domestic and international price data being analyzed. As shown in Table 6 and Table 7, staple grain prices in Sub-Saharan Africa are almost universally higher than the world prices of the same commodities, in some cases significantly higher. For example, the average world price of rice was $210 per ton, but the average price of rice in Ghana varied from $334 to $734, depending on the location. Similarly, the average world price of maize was $121 per ton, but the average maize price in different markets in Mozambique ranged from $177 to $285 per ton. Finally, the average world price of wheat was $167 per ton, but the Ethiopian wheat price averaged $261 per ton. The only exceptions were the price of maize in Kampala (Uganda), which averaged 24 percent below the world price, and the price of maize in Songea (Tanzania), which was approximately equal to the average world price.

Table 6. Descriptive statistics of the domestic price data

Country	City	Commodity	N	Mean	Min	Max	Std. Dev.
Ethiopia	Addis Ababa	Maize	180	170	55	609	87
	Addis Ababa	Sorghum	177	299	126	943	168
	Addis Ababa	Wheat	180	261	121	771	99
Ghana	Accra	Imported rice	48	370	283	429	32
	Kumasi	Imported rice	48	372	285	456	28
	Kumasi	Local rice	48	734	412	832	117
	Tamale	Local rice	45	334	243	650	82
	Tamale	Local rice	46	438	310	528	56
	Techiman	Local rice	48	341	224	491	76
	Techiman	Local rice	48	500	343	597	66
Kenya	Mombasa	Maize	180	210	104	363	51
	Nairobi	Maize	180	220	64	434	64
Malawi	Chitipa	Maize	171	145	55	466	68
	Karonga	Maize	171	158	49	445	75
	Lilongwe	Maize	171	156	42	515	77
	Lunzu	Maize	153	194	69	535	92
	Mitundu	Maize	153	148	42	517	80
	Mzuzu	Maize	153	169	56	423	65
	Nkhata Bay	Maize	171	188	57	649	88
	Rumphi	Maize	171	175	56	637	73
Mozambique	Beira	Maize	69	201	98	494	93
	Chokwe	Maize	69	252	141	535	98
	Chokwe	Rice	69	414	241	783	96
	Gorongosa	Rice	69	177	84	619	111

Table 6. Continued

Country	City	Commodity	N	Mean	Min	Max	Std. Dev.
Mozambique	Gorongosa	Rice	69	533	326	1176	195
	Maputo	Rice	69	285	183	529	87
	Maputo	Rice	69	472	250	814	144
	Nampula	Rice	69	212	109	454	90
	Nampula	Rice	69	502	274	1060	208
	Tete	Rice	69	201	102	621	112
	Tete	Rice	69	657	339	1157	195
	Durban	White maize	204	136	56	199	37
	Durban	Yellow maize	204	128	56	201	32
	Randfontein	White maize	228	158	73	279	41
	Randfontein	Yellow maize	228	152	72	298	42
South Africa	Arusha	Maize	60	170	108	293	44
	Arusha	Rice	60	513	271	897	106
	Arusha	White maize	60	182	104	547	81
	Dar es Salam	White maize	60	171	114	271	44
Tanzania	Dar es Salam	White maize	60	512	295	746	102
	Dar es Salam	Sorghum	60	264	147	657	91
	Dar es Salam	Sorghum	60	180	99	503	75
	Mbeya	Sorghum	60	135	79	282	44
	Mtwara	Sorghum	60	183	75	381	65
	Mtwara	Sorghum	60	519	340	750	97
	Mtwara	Sorghum	60	258	174	383	50
	Singida	Sorghum	60	170	92	302	51
	Singida	Sorghum	60	488	269	785	106
	Singida	Sorghum	60	174	103	286	50
	Songea	Sorghum	60	121	69	308	45
	Songea	Sorghum	60	416	172	621	84
	Kampala	Maize	93	92	32	229	39
	Mbale	Maize	69	130	51	199	38
	Chipata	Maize	68	207	119	376	67
	Choma	Maize	68	173	99	334	62
Uganda	Kabwe Urban	Maize	68	194	97	458	73
	Kasama	Maize	68	192	97	380	73
Zambia	Kitwe	Maize	68	211	114	424	76
	Lusaka	Maize	68	225	122	376	61
	Mansa	Maize	68	205	91	408	85
	Mongu	Maize	68	216	102	420	63
	Solwezi	Maize	68	199	70	401	83

Source: Authors' calculations based on price data from the Famine Early Warning Network (FEWS-NET) project, the Regional Agricultural Trade Intelligence Network (RATIN, and national statistics offices.

Table 7. Descriptive statistics of international price data

Commodity	Location	N	Mean	Min	Max	Std. Dev.
Rice	Thailand	228	210	122	772	88
Maize	US Gulf	179	121	75	294	39
Wheat	US Gulf	228	167	105	482	61

Source: Authors' calculations based on price data from FAO 2009b
Note: Rice price refers to Thai Super A1 broken white rice, FOB Bangkok. Maize price refers to U.S. No 2 yellow maize, FOB Gulf of Mexico. Wheat price refers to U.S. No 2 hard red winter wheat, FOB Gulf of Mexico.

There are four likely reasons for the higher prices in Africa:

- First, the African prices are generally wholesale and retail prices, so they refer to purchases in smaller volumes and include local marketing margins.
- Second, for some crops, particularly rice and wheat, the cost of production and marketing is generally higher in Africa, as a result of lower yields, higher rates of spoilage, and higher costs of transportation.
- Third, the cost of sea-freight and overland transportation means that the full cost of delivering imported grain to African markets (the import parity price) is higher than the world price.
- Fourth, in many cases import tariffs, import restrictions, or administrative procedures raise the cost of importing grain or prevent grain imports, raising the domestic price above the import parity price.

In addition to the differences between domestic and world prices, there are significant disparities between prices in different countries. For example, the price of white maize in Durban is $136 per ton, but 470 kilometers up the coast in Maputo, the price of maize is $285 per ton. In addition, the price of local rice in Tamale (northern Ghana) is $438, compared to $734 in Kumasi (central Ghana). In both case, it is difficult to imagine that the cost of transportation could explain such large differences.

Finally, Table 8 compares the coefficient of variation (CV), a common measure of volatility, in grain prices in Sub-Saharan Africa and world markets. The coefficient of variation is the ratio of the standard deviation to the mean of the world price. The coefficient of variation of the import parity price is estimated assuming that the import parity price is $100 per ton greater than the world price. In the case of maize, African prices are substantially more volatile than the estimated import parity price of maize. Although not shown here, the volatility of maize prices in South Africa, a source of imported maize for many African countries, is also significantly lower than maize prices in Sub-Saharan Africa in general. In the case of rice, the estimated volatility of the import parity price is slightly higher than that of domestic African prices. In the case of wheat, we have only one wheat price, that of Addis Ababa. This Addis Ababa wheat price is more volatile than the estimated import parity price of wheat.

Table 8. Comparison of price volatility

Commodity	Mean (US$/ton)	Standard deviation	Coefficient of variation	Coefficient of variation of import parity
World prices				
Maize	121	39	33%	18%
Rice	210	88	42%	28%
Wheat	167	61	36%	23%
Domestic prices in Sub-Saharan Africa				
Maize	180	68	38%	
Rice	477	105	22%	
Wheat	261	99	38%	

Source: Authors' calculations based on price data from FEWS-NET, RATIN, national statistics offices, and FAO 2009b.

Turning to the econometric analysis, Table 9 provides a summary of the results for seven prices from three eastern African countries: Ethiopia, Kenya, and Uganda. The augmented Dickey-Fuller test indicates that five of the seven African prices have unit roots, while the Phillips-Perron test suggests that six of the seven have unit roots. As described in section 2.2, a price with a unit root is one that follows a "random walk" without any tendency to return to a long-run average. It also implies that the econometric analysis needs to be carried out with an error correction model using the change in prices ($p_t - p_{t-1}$) rather than an autoregressive model using the level of prices (p_t).

Table 9. Transmission of world food prices to domestic markets in Ethiopia, Kenya, and Uganda

			Unit root in domestic price?		Long-run relationship?	Error correction model (if long run-relationship confirmed)		
			A DF test	**Phillips-Perron test**	**Johansen test**	**Speed of Adjust-ment**	**Short-run Adjust-ment**	**Long-run Adjust-ment**
Country	Location	Commodity						
Ethiopia	Addis Ababa	Maize	Yes	Yes	No			
Ethiopia	Addis Ababa	Sorghum	No	Yes	No			
Ethiopia	Addis Ababa	Wheat	No	No	Stationary			
Kenya	Mombasa	Maize	Yes	Yes	Stationary			
Kenya	Nairobi	Maize	Yes	Yes	Stationary			
Uganda	Kampala	Maize	Yes	Yes	No			
Uganda	Mbale	Maize	Yes	Yes	Stationary			

Source: Authors' analysis using price data from various sources.

Next, we use the Johansen cointegration test to see if there is a long-run relationship between each domestic price and the corresponding international price. In three of the seven, the Johansen test indicates that there is no statistically significant long-run relationship. In the other four, the Johansen test suggests that the variables are stationary, that is, they are integrated: I(0). This suggests the need for a vector autoregression (VAR) model estimating the domestic price as a function of lagged domestic prices and international prices, with all variables expressed in logarithms. Using just one month of lagged terms, the international price has a statistically significant effect on the domestic price the next month in three of the four cases (Nairobi maize, Mombasa maize, and Addis Ababa wheat). However, the coefficients suggest that the relationship is fairly weak, with a short-term transmission of just eight to nine percent of the change in international prices. Statistical tests[9] indicate the need to include two months of lagged terms, and in this version of the VAR, the coefficients on the world price are both small and statistically insignificant.

As shown in Table 10, of the eight maize markets in Tanzania, only in Arusha was there a significant long-run relationship with the world price of maize. In this case, about 54 percent of the variation in world prices is eventually transmitted to the maize price in Arusha. This may be the result of the location of Arusha, near the Kenyan border. Although Tanzania is only an occasional and marginal importer of maize, Kenya imports maize on a regular basis. In addition, there is cross-border trade in maize from Tanzania to Kenya, which may indirectly link Arusha prices to the world market.

Four of the eight rice markets in Tanzania appeared to be linked to world rice markets. The elasticity of price transmission ranges from 0.24 to 0.54, suggesting that 24 to 54 percent of the changes in world rice prices are transmitted to Tanzanian markets.

[9] The Akaike information criterion (AIC) was used to select the lag length, but this test generally agreed with other tests such as Schwarz's Bayesian information criterion and the Hannan-Quinn information criterion.

Table 10. Transmission of world food prices to domestic markets in Tanzania

			Unit root in domestic price?		Long-run relationship?	Error correction model (if long run-relationship confirmed)		
			A DF test	**Phillips-Perron test**	**Johansen test**	**Speed of Adjust-ment**	**Short-run Adjust-ment**	**Long-run Adjust-ment**
Country	Location	Commodity						
Tanzania	Arusha	Maize	No	No	Yes	0.54 *	-0.23	0.54
Tanzania	Dar es Salam	Maize	Yes	Yes	No			
Tanzania	Mbeya	Maize	No	No	No			
Tanzania	Arusha	Maize	Yes	Yes	No			
Tanzania	Dar es Salam	Maize	Yes	Yes	No			
Tanzania	Mtwara	Maize	No	No	No			
Tanzania	Singida	Maize	Yes	Yes	No			
Tanzania	Songea	Maize	No	Yes	No			
Tanzania	Arusha	Rice	No	No	No			
Tanzania	Dar es Salam	Rice	No	No	Yes	0.58 *	1.12 *	0.54 *
Tanzania	Mtwara	Rice	No	No	Yes	0.50 *	0.77	0.28
Tanzania	Singida	Rice	No	No	No			
Tanzania	Songea	Rice	No	No	Yes	0.65 *	0.86	0.24
Tanzania	Dar es Salam	Sorghum	No	No	No			
Tanzania	Mtwara	Sorghum	Yes	Yes	Yes	0.30 *	0.84	0.54 *
Tanzania	Singida	Sorghum	Yes	Yes	No			

Source: Authors' analysis using price data from various sources.
Note: * statistically significant at the 5% level.

The results for Malawi are shown in Table 11. Only three of the eight maize markets in Malawi showed a significant long-run relationship with the world maize price: Chitipa, Lilongwe, and Nkhata Bay. Chitipa is located in the northern tip of Malawi and adjacent to the main maize surplus zone of Tanzania. The elasticity of transmission is large (0.70) but not statistically significant at the 5 percent level (it is, however, significant at the 10 percent level). Lilongwe is the capital city and headquarters of the state-owned Agricultural Development and Marketing Corporation ADMARC, which generally manages international trade in maize. The long-run elasticity of price transmission is not statistically significant. Nkhata Bay is an important port on Lake Malawi, located in the north center of the country. Again, the long-run elasticity of price transmission is not significant.

Table 11. Transmission of world food prices to domestic markets in Malawi

			Unit root in domestic price?		Long-run relationship?	Error correction model (if long run-relationship confirmed)		
			A DF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
Country	Location	Commodity						
Malawi	Chitipa	Maize	Yes	No	Yes	0.14 *	0.09	0.70
Malawi	Karonga	Maize	No	No	No			
Malawi	Lilongwe	Maize	No	No	Yes	0.20 *	0.44	-0.07
Malawi	Lunzu	Maize	No	No	No			
Malawi	Mitundu	Maize	No	No	No			
Malawi	Mzuzu	Maize	No	No	No			
Malawi	Nkhata Bay	Maize	No	No	Yes	0.20 *	0.44	0.07
Malawi	Rumphi	Maize	Yes	Yes	No			

Source: Authors' analysis using price data from various sources.
Note: * statistically significant at the 5% level.

Table 12 provides the results for nine maize markets in Zambia. The Johansen test indicates that none of the local prices had a long-run relationship with international maize prices.

The results for Mozambique are presented in Table 13, including tests for six maize markets and five rice markets. None of the six maize markets showed evidence of a long-run relationship between local and international maize prices. On the other hand, four of the five rice markets in the country did show a long-run relationship with world rice prices. The long-run elasticity of price transmission is statistically significant in these four rice markets. The elasticity is relatively high for Nampula, an inland city in the north, and Tete, located in the remote western part of Mozambique, between Zimbabwe and Malawi. The long-run elasticity of price transmission is smaller in Chokwe and Gorongosa. The only rice market whose price is not cointegrated with the world price is Maputo, the capital city, located at the southern tip of the country.

Table 12. Transmission of world food prices to domestic markets in Zambia

			Unit root in domestic price?		Long-run relationship?	Error correction model (if long run-relationship confirmed)		
			A DF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
Country	Location	Commodity						
Zambia	Chipata	Maize	Yes	Yes	No			
Zambia	Choma	Maize	Yes	Yes	No			
Zambia	Kabwe urban	Maize	Yes	Yes	No			
Zambia	Kasama	Maize	Yes	No	No			
Zambia	Kitwe	Maize	Yes	Yes	No			
Zambia	Lusaka	Maize	Yes	Yes	No			
Zambia	Mansa	Maize	Yes	Yes	No			
Zambia	Mongu	Maize	Yes	No	No			
Zambia	Solwezi	Maize	No	No	No			

Source: Authors' analysis using price data from various sources.

Table 13. Transmission of world food prices to domestic markets in Mozambique

			Unit root in domestic price?		Long-run relationship?	Error correction model (if long run-relationship confirmed)		
			A DF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
Country	Location	Commodity						
Mozambique	Beira	Maize	Yes	Yes	No			
Mozambique	Chokwe	Maize	Yes	Yes	No			
Mozambique	Gorongos	Maize	Yes	Yes	No			
Mozambique	Maputo	Maize	Yes	Yes	No			
Mozambique	Nampula	Maize	Yes	Yes	No			
Mozambique	Tete	Maize	Yes	Yes	No			
Mozambique	Chokwe	Rice	No	No	No	0.37 *	-0.24	0.39 *
Mozambique	Gorongos	Rice	Yes	Yes	No	0.31 *	-0.23	0.16 *
Mozambique	Maputo	Rice	Yes	Yes	No			
Mozambique	Nampula	Rice	Yes	Yes	No	0.30 *	-0.24	0.97 *
Mozambique	Tete	Rice	Yes	Yes	No	0.30 *	-0.40 *	0.70 *

Source: Authors' analysis using price data from various sources.
Note: * statistically significant at the 5% level.

As shown in Table 14, we analyzed the relationship between four maize prices in South Africa and world maize prices. The unit root tests confirm that all four prices are nonstationary in levels but stationary in differences. However, the Johansen test indicates that the domestic and international prices are stationary in levels. This suggests the need to adopt a vector autoregression (VAR) model of the level of the domestic price, as discussed above in the case of the eastern African prices. In both one- and two-month lag versions of the VAR, world maize prices had no significant effect on South African maize prices.

Table 14. Transmission of world food prices to domestic markets in South Africa

			Unit root in domestic price?		Long-run relationship?	Error correction model (if long run-relationship confirmed)		
Country	Location	Commodity	A DF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
South Africa	Durban	White maize	Yes	Yes	Stationary			
South Africa	Randfontein	White maize	Yes	Yes	Stationary			
South Africa	Durban	Yellow maize	Yes	Yes	Stationary			
South Africa	Randfontein	Yellow maize	Yes	Yes	Stationary			

Source: Authors' analysis using price data from various sources.

Table 15 shows the results of testing the cointegration of Ghanaian rice prices with world rice prices. Of the seven rice markets in the country, only one shows a significant relationship with the world rice price: Kumasi, a major city in the south-central region of the country. The long-run elasticity of price transmission is 0.47, but it is not statistically significant.

Table 15. Transmission of world food prices to domestic markets in Ghana

			Unit root in domestic price?		Long-run relationship?	Error correction model (if long run-relationship confirmed)		
Country	Location	Commodity	ADF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
Ghana	Accra	Imported rice	No	No	No			
Ghana	Kumasi	Imported rice	Yes	Yes	No			
Ghana	Tamale	Imported rice	No	No	No			
Ghana	Techiman	Imported rice	Yes	Yes	No			
Ghana	Kumasi	Local rice	No	No	Yes	0.20 *	-0.13	0.47
Ghana	Tamale	Local rice	No	No	No			
Ghana	Techiman	Local rice	Yes	Yes	No			

Source: Authors' analysis using price data from various sources.
Note: * statistically significant at the 5% level.

The maize results presented above are based on testing the long-run relationship between domestic maize prices in Sub-Saharan Africa and the world maize price in the form of the U.S. No 2 yellow maize price in the Gulf of Mexico. There are two reasons to think that domestic African prices may be more closely related to South African maize prices than to world prices. First, a number of southern and eastern African countries import maize from South Africa rather than from markets outside Africa. Second, yellow maize dominates world markets for maize, but white maize is strongly preferred among African consumers. South Africa is one of the few countries that exports white maize in significant volumes. For this reason, we carried out the error correction model comparing domestic maize prices with the South African Futures Exchange (SAFEX) white maize price. Somewhat surprisingly, the results were the qualitatively the same: Very few of the domestic maize prices showed a long-run relationship with the South African maize prices.

The results of the econometric analysis of the link between world and African domestic prices are summarized by country in Table 16. Overall, 13 of the 62 staple food prices tested showed a statistically significant long-run relationship with world prices according to the Johansen cointegration test. Malawi, Mozambique, and Ethiopia have the highest proportion of prices that are linked to world markets, though the percentage is less than 40 percent even in these countries. Zambia, Uganda, South Africa, and Kenya have no prices that show a long-run relationship with world markets.

Table 16. Summary of price transmission by country

	Prices with relationship	Total nbr. of prices	Percentage
Ethiopia	1	3	33%
Ghana	1	7	14%
Kenya	0	2	0%
Malawi	3	8	38%
Mozambique	4	11	36%
South Africa	0	4	0%
Tanzania	4	16	25%
Uganda	0	2	0%
Zambia	0	9	0%
Total	13	62	21%

Source: Authors' analysis using price data from various sources.

Table 17 summarizes the results by commodity. It reveals that almost half of the rice prices have a statistically significant long-run relationship with world rice prices. In contrast, the proportion is just 10 percent for maize. Thus, according to the econometric analysis of prices, rice markets in Africa are generally better connected to world markets than are maize markets.

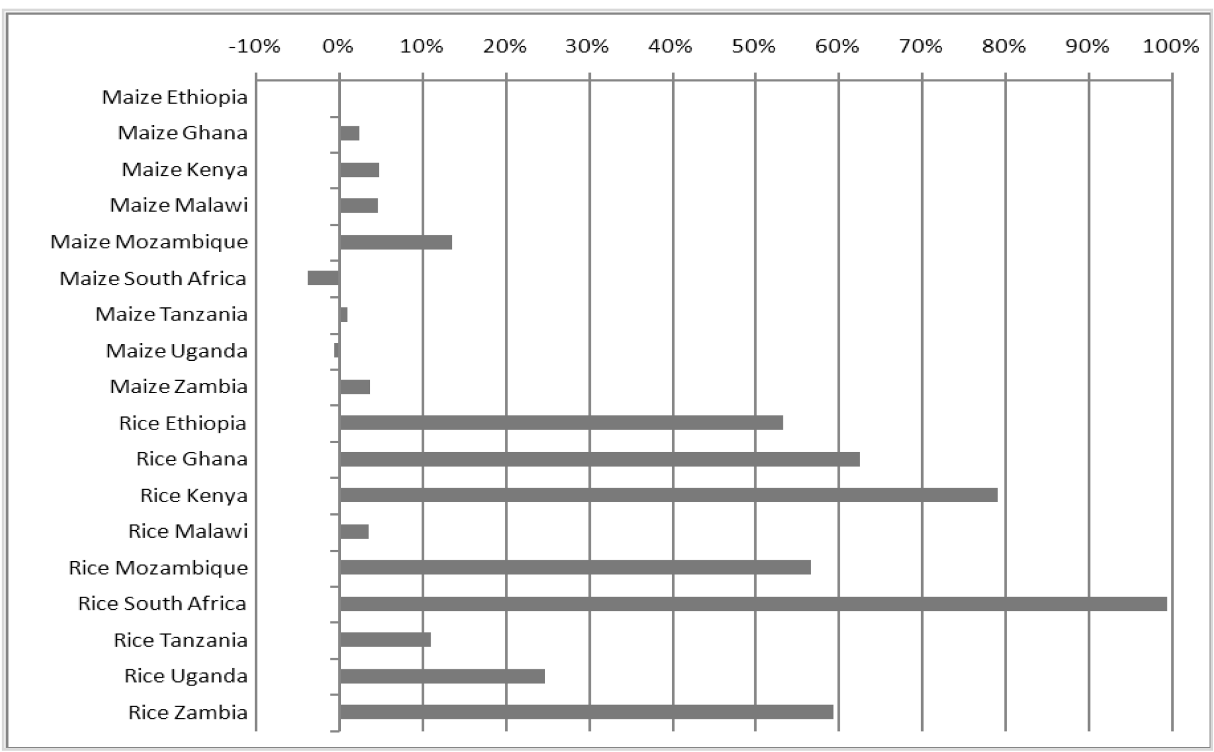
Table 17. Summary of price transmission by commodity

	Prices with relationship	Total nbr. of prices	Percentage
Maize	4	40	10%
Rice	8	17	47%
Sorghum	1	4	25%
Wheat	0	1	0%
Total	13	62	21%

Source: Authors' analysis using price data from various sources.

These results are understandable in light of the relative importance of trade in maize and rice. As shown in Figure 2, maize trade represents no more than 5 percent of domestic apparent consumption in all but one country (Mozambique is the exception). In contrast, most of the countries under consideration are highly reliant on rice imports. Imports account for more than half of apparent domestic consumption of rice in six of the nine countries.

Figure 2. Net imports of maize and rice as a percentage of apparent consumption for selected African countries



Source: FAO 2009a.
Note: Apparent consumption is defined as production plus net imports.

5. SUMMARY AND IMPLICATIONS

This section reviews the results of the study and discusses some implications. Section 5.1 summarizes the trends in staple food prices in Sub-Saharan Africa over the period 2007–2008. Section 5.2 describes the econometric analysis of price transmission from international markets to domestic markets in Africa. The implications of the results of the study for policy are discussed in Section 5.3, and the implications for future research are described in Section 5.4.

5.1. Staple Food Price Trends in Sub-Saharan Africa

Staple food prices in Sub-Saharan Africa have risen rapidly since 2006, even in U.S. dollar terms. Across 83 food prices in 12 countries examined, the average increase between June 2007 and June 2008 was 63 percent in U.S. dollar terms. This represents an average of 71 percent of the increase in the price on international markets for the corresponding commodities. There is, however, considerable variation across countries and commodities. For example, food price increases were relatively small (25–39 percent) in South Africa, Ghana, and Cameroon. On the other hand, food price increases were quite large (over 150 percent) in Ethiopia and Malawi. Since the price increases in these latter two countries actually exceeded the price increase in the world markets for the same commodities, this suggests that the world price was not the only factor contributing to the price increases: domestic factors (such as supply shortages or policy failures) must have also played a role. The price increases in domestic African markets also varied by commodity. The price increases in African markets were highest for maize (87 percent), followed by wheat (65 percent) and rice (62 percent). Other commodities experienced smaller increases, particularly plantains (9 percent) and cassava (12 percent). The degree of price increase appears to be related to the degree of tradability: As described in section 2.2, highly tradable commodities are more closely linked to international markets, so domestic prices of these commodities tracked the spike in world prices. Commodities that are less widely traded in international markets saw smaller price increases in African markets.

5.2. Econometric Analysis of Food Price Transmission from International to African Markets

The above analysis is based on the simple ratio of local to international price increases over June 2007 to June 2008. We also carried out an econometric analysis of the degree to which local prices track world prices using a vector error correction model. The data consisted of 62 domestic price series for maize, rice, and wheat in nine Sub-Saharan African countries. Each domestic price series was tested against the world price of the same commodity.

Based on the Johansen test, only 13 of the 62 price series showed a long-run relationship in which the domestic price was influenced by the international price of the same commodity. Of the 13 domestic prices that showed a long-run relationship with international prices, only 6 had a long-term elasticity of transmission that was statistically significant. These 6 elasticities ranged from 0.16 to 0.97, with a median value of 0.54. The median value implies that 54 percent of a percentage change in international prices would be transmitted to the domestic price of the same commodity.

Although barely one-fifth of the 62 African prices tested showed a statistically significant link to international prices, there was some variation in the proportion across countries and commodities. Malawi, Mozambique, and Ethiopia had the highest proportion of prices that were linked to world markets, though the share was less than 40 percent in all three cases. Zambia, Uganda, and Kenya had no prices that showed a long-run relationship with world markets.

The differences across commodities were somewhat clearer. Just 10 percent of the domestic maize prices tested was significantly related to world maize prices, but almost half of the domestic rice prices were related to world rice prices. This implies that rice markets in Africa were generally better connected to world markets than were maize markets. This result is not surprising in light of the fact that most Sub-Saharan African countries are close to self-sufficient in maize but rely heavily on imported rice to meet local demand. More specifically, the traded volume of maize is equivalent to less than 5 percent of the domestic consumption in eight of the nine countries under consideration; the exception is Mozambique, where maize imports are equivalent to 14 percent of domestic production. Among the three countries whose rice prices were tested, rice imports represent more than 50 percent of domestic consumption in Ghana and Mozambique and 11 percent in Tanzania.

A key question is how to reconcile the trend analysis, which shows almost all domestic African prices rising, apparently in response to the global food crisis of 2007–2008, and the econometric analysis, which suggests that often there was no relationship between world prices and domestic African prices for the same commodities. There are several possible explanations for this.

First, the two analyses cover different time periods: The trend analysis describes price increases over June 2007 to June 2008, while the econometric analysis covers the last four to eight years. It is possible that policy reforms in recent years have made African markets more responsive to conditions of world markets. This hypothesis seems unlikely, however. Although African economies are more open than they were in the early 1990s, there has been no dramatic movement toward liberalized trade that would make transmission higher in 2007–2008 than in 2003–2007.

Second, unlike normal fluctuation in world food prices, the food crisis coincided with a sharp increase in oil prices, from $71 per barrel in June 2007 to $133 per barrel a year later (see Figure 1). This led to much higher costs for fertilizer, sea freight, and overland transportation, which raised the cost of both domestically, produced and imported food. Since fuel costs represent less than half of transportation costs, and transportation costs generally account for up to half of imported food costs, an 87 percent increase in fuel prices could account for a 20 to 25 percent increase in imported grain costs. Thus, higher fuel costs may be an important contributing factor, but they are not enough to explain the full increase in African staple food prices.

Third, the food crisis provoked a wave of grain export restrictions in Sub-Saharan Africa as well as elsewhere. As mentioned above, during the food crisis, Malawi, Zambia, and Tanzania all banned the export of maize, while several western African countries attempted to ban grain exports with varying degrees of success (see Staatz et al. 2008). Although the effect is difficult to quantify, these restrictions probably raised grain prices in landlocked countries.

Fourth, in some cases, policy responses and local factors exacerbated the effect of the global food crisis. In Ethiopia, local grain prices rose above import parity price because fuel subsidies and restrictions on the foreign exchange market created a shortage of foreign currency, preventing private traders from importing grain. In Kenya, post-election disturbances and poor rains contributed to a smaller-than-average harvest, and maize imports were impeded by a high tariff and delays in government importation. In Malawi, a government procurement program for export (possibly based on overestimates of the harvest) and tight restrictions on private trade contributed to a spike in domestic maize prices, which exceeded the import parity price.

Fifth, there are likely to be threshold effects such that small changes in world food prices are not transmitted to African markets or their effects on African markets are not measurable given the price fluctuations due to variation in domestic supply. Most African grain prices exhibit large spikes that are unrelated to world prices and are presumably driven by poor harvests. However, when the shock from international markets is large, as it was in 2007–2008, the price changes are transmitted to local markets or at least the transmission to local markets becomes measurable.

In summary, we conclude that international prices of food grains do have some effect on African markets for rice and (to a lesser degree) maize, but the effect is usually swamped by the dominant effect of weather-related domestic supply shocks. The spike in world prices in 2007–2008 was more clearly transmitted because (1) it was a large shock, (2) it was accompanied by sharply higher transportation costs, (3) attempts by African countries to ban grain exports contributed to food price increases in neighboring countries, and (4) local factors and restrictions on private trade exacerbated the price increases in some countries.

5.3. Policy Implications of the Findings

The global food crisis of 2007–2008 has understandably shaken confidence in the stability and reliability of world food markets. In many countries, it has sparked renewed interest in food self-sufficiency, trade barriers, and strategic grain reserves.

In light of these findings, an obvious question is this: How can African countries reduce vulnerability to fluctuations in world food prices? The simplest answer is staple food self-sufficiency, but how is this to be achieved? One approach would be to invest in agricultural research, extension, disease control, and methods for reducing post-harvest losses. Based on numerous studies of the returns to agricultural research, this would probably be a good investment regardless of the net trade position of the country in staple foods and regardless of whether it succeeded in achieving self-sufficiency (see Alston et al. 2000 for a review of studies of the returns to agricultural research). But it would be a long-term strategy, which limits its appeal in the political arena. The likelihood of success varies by crop: For maize, it would be feasible given that most African countries are 90 to 95 percent self-sufficient in maize already. For rice and wheat, the rate of self-sufficiency could be increased, but for most eastern and southern African countries, yield improvements alone are not likely to be enough to reach self-sufficiency.[10]

Another approach, probably more appealing in the short term, is to restrict imports through tariffs, quotas, or an import ban. If enforceable, these policies would increase the rate of self-sufficiency quickly at no cost to the government, but they would raise the price of staple foods significantly, probably above the levels experienced during the global food crisis. Since rice and wheat imports continued during this period, the "self-sufficiency" price for these commodities must be still higher. This means that avoiding vulnerability to a spike in world grain prices like the one in 2007–2008 would require keeping grain prices permanently at or above the levels experienced during the height of the global food crisis. Clearly, this would have serious adverse effects on the food security of many households, particularly the urban poor.

In addition, staple food self-sufficiency would not eliminate food price volatility; rather, it would decrease volatility due to international markets but increase volatility due to domestic supply shocks. The key question is whether price volatility due to domestic supply shocks would be greater or less than volatility due to international grain markets. Although more in-depth analysis would require trade modeling beyond the scope of this study, several pieces of evidence suggest that price volatility due to domestic supply shocks is as large as or larger than volatility due to international markets:

- The price of maize in South Africa (a source of imported maize for its neighbors) is more stable than the price of maize in most other Sub-Saharan African countries. The coefficient of variation (CV) of maize prices on the South African commodity exchange is about 0.26, compared to an average of 0.38 in Sub-Saharan Africa in general.
- The estimated import parity price of U.S. maize in Sub-Saharan Africa is more stable than the domestic price of maize in most Sub-Saharan African countries. The estimated CV of the import parity price of U.S. maize is just 0.18. This is based on a conservative (low) assumption of $100 per ton cost of delivery. If the delivery cost is higher, the CV of the import parity price would be even lower.
- In markets of Sub-Saharan Africa, the price of rice (a largely tradable grain) is more stable than the price of maize (a largely nontradable grain). The average CV of rice prices in 13 African markets is 0.22, compared to the average CV of maize prices in 40 African markets of 0.38.

As discussed above, the global food crisis was exacerbated when several major exporters (including Argentina, Russia, India, and Vietnam) restricted grain exports in response to the rising prices.

[10] Madagascar and Tanzania import less than 10 percent of their rice requirements, so rice self-sufficiency is a feasible target there.

As food importers, the countries of Sub-Saharan Africa have a strong interest in limiting this kind of behavior. One way to do this would be to lobby the World Trade Organization and other international bodies to establish rules limiting the use of food export restrictions as part of multilateral trade agreements.

Similarly, the effects of another spike in world food prices could be ameliorated if African countries themselves refrained from banning grain exports. Although these bans are understandable from the perspective of an individual country, the combined effect of many countries doing this is to exacerbate the price spike, particularly for landlocked and food-importing countries. Given this situation, any effort to prevent food export bans would have to be carried out at the regional level rather than at the national level. In addition, an effort by African countries to discipline food export restrictions at the global level would be more persuasive if these countries were undertaking similar measures at the regional level.

The experience of Ethiopia, Malawi, and other countries indicates that grain prices occasionally exceed the import parity price because of (1) the rationing of foreign exchange to prevent depreciation of the currency, (2) the inability of traders to obtain food import permits, and (3) uncertainty regarding the government's intentions regarding food imports. The policy implications are as follows:

- Either allows the currency to depreciate in order to avoid foreign exchange shortages that constrain food importers or (as a second-best solution) give priority to food imports in rationing foreign currency.
- Remove the requirement that importers obtain permits to import food grains, although they should be required to register the import orders for data collection and transparency purposes.
- Governments need to provide a clear and predictable environment for traders to make decisions. One approach would be for the government to withdraw from the business of trading in food grains. If this is not politically feasible, the government needs to be as transparent as possible in its trading decisions. Subsidized sales of grain by the government should be targeted to poor and vulnerable groups rather than made available to, for example, all urban consumers.

In the longer term, African governments can promote resilience to volatility in international grain prices by diversifying the staple foods diet of consumers. During the global food crisis, the domestic prices of cassava, sweet potatoes, and other nontradable staple foods rose much less than the prices of rice, wheat, and maize. Having a diversified diet allows households to substitute toward less expensive staples when the price of one of them rises. Staple crop diversification can be promoted on the production side by investing in cassava and other root crops, particularly in the areas of developing disease-resistant varieties and distributing improved planting materials. On the consumption side, efforts can be made to develop and disseminate methods for processing root crops and nontradable grains to increase shelf life and make food preparation easier.

5.4. Implications for Research

The results presented in this study raise a number of questions and issues for future research on price transmission and the welfare impact of food price increases.

First, the error correction model measures the degree of co-movement in prices regardless of whether the price difference justifies trade between the two locations. A low degree of price transmission may be due to inefficient markets, justifiably high costs of moving commodities between distant locations, or both. A threshold autoregressive model distinguishes between situations when the price difference is large, justifying trade between the markets and co-movement of prices, and when the price difference is small, during which no co-movement is expected (see Van Campenhout 2007 and Myers 2008). Such a model would provide additional information on the "threshold" price difference, below which co-movement ceases. The threshold can be considered a measure of the actual marketing cost between the two markets, including normal profit and risk premiums.

Second, more research is needed to explain the paradox that (1) long-term econometric analysis reveals that few African prices are linked to world commodity markets, yet (2) domestic prices in African markets rose sharply during the world food crisis of 2007–2008. Several hypotheses to explain this were proposed in section 5.2. Further research would help to narrow the list of possible explanations.

Third, the research could be extended to a larger set of African countries, a larger set of grain prices within each country, a longer series of price data, or a combination of these. In particular, not all the price series included the period of the global food crisis, so it would be useful to update the analysis by including more recent price data.

APPENDIX: SUPPLEMENTARY TABLES

Characteristics of Price Data Used in Econometric Analysis

Table A.1. Characteristics of international price data

Commodity	Details	Time period	Source
Maize	U.S. No 2 yellow maize, FOB Gulf of Mexico	Jan 90–Dec 08	FAO 2009b
Maize SAFEX	South African white maize, FOB Johannesburg	Jan 90–Dec 08	SAFEX 2009
Wheat	U.S. No 2 hard red winter wheat, FOB Gulf of Mexico	Jan 90–Dec 08	FAO 2009b
Rice	Thai Super A1 broken rice, FOB Bangkok	Jan 90–Dec 08	FAO 2009b
Sorghum	U.S. No 2 yellow sorghum, FOB Gulf of Mexico	Jan 90–Dec 08	FAO 2009b

Source: Authors' compilation.

Table A.2. Characteristics of domestic price data from Sub-Saharan Africa

Country	Commodity	Market	Time period
Ethiopia	Addis Ababa	Maize	Mar 94–Dec 08
Ethiopia	Addis Ababa	Sorghum	Mar 99–Nov 08
Ethiopia	Addis Ababa	Wheat	Mar 94–Dec 08
Ghana	Accra	Imported rice	Mar 04–Dec 07
Ghana	Kumasi	Imported rice	Mar 04–Dec 07
Ghana	Tamale	Imported rice	Apr 04–Oct 07
Ghana	Techiman	Imported rice	Mar 04–Dec 07
Ghana	Kumasi	Local rice	Mar 04–Dec 07
Ghana	Tamale	Local rice	Mar 04–Oct 07
Ghana	Techiman	Local rice	Mar 04–Dec 07
Kenya	Mombasa	Maize	Mar 94–Nov 08
Kenya	Nairobi	Maize	Mar 94–Nov 08
Malawi	Chitipa	Maize	Mar 94–Mar 08
Malawi	Karonga	Maize	Mar 94–Mar 08
Malawi	Lilongwe	Maize	Mar 94–Mar 08
Malawi	Lunzu	Maize	Mar 94–Sep 06
Malawi	Mitundu	Maize	Mar 94–Sep 06
Malawi	Mzuzu	Maize	Mar 94–Sep 06
Malawi	Nkhata Bay	Maize	Mar 94–Mar 08
Malawi	Rumphi	Maize	Mar 94–Mar 08
Mozambique	Beira	Maize	Jun 03–Dec 08
Mozambique	Chokwe	Maize	Jun 03–Dec 08
Mozambique	Gorongosa	Maize	Jun 03–Dec 08
Mozambique	Maputo	Maize	Jun 03–Dec 08
Mozambique	Nampula	Maize	Jun 03–Dec 08
Mozambique	Tete	Maize	Jun 03–Dec 08
Mozambique	Chokwe	Rice	Jun 03–Dec 08
Mozambique	Gorongosa	Rice	Jun 03–Dec 08
Mozambique	Maputo	Rice	Jun 03–Dec 08
Mozambique	Nampula	Rice	Jun 03–Dec 08
Mozambique	Tete	Rice	Jun 03–Dec 08
South Africa	Durban	White maize	Mar 94–Dec 06
South Africa	Randfontein	White maize	Mar 94–Dec 08

Table A.2. Continued

Country	Commodity	Market	Time period
South Africa	Durban	Yellow maize	Mar 94–Dec 06
South Africa	Randfontein	Yellow maize	Mar 94–Dec 08
Tanzania	Arusha	Maize	Mar 03–Dec 07
Tanzania	Dar es Salaam	Maize	Mar 03–Dec 07
Tanzania	Mbeya	Maize	Mar 03–Dec 07
Tanzania	Mtwara	Maize	Mar 03–Dec 07
Tanzania	Singida	Maize	Mar 03–Dec 07
Tanzania	Songea	Maize	Mar 03–Dec 07
Tanzania	Arusha	Rice	Mar 03–Dec 07
Tanzania	Dar es Salaam	Rice	Mar 03–Dec 07
Tanzania	Mtwara	Rice	Mar 03–Dec 07
Tanzania	Singida	Rice	Mar 03–Dec 07
Tanzania	Songea	Rice	Mar 03–Dec 07
Tanzania	Dar es Salaam	Sorghum	Mar 03–Dec 07
Tanzania	Mtwara	Sorghum	Mar 03–Dec 07
Tanzania	Singida	Sorghum	Mar 03–Dec 07
Uganda	Kampala	Maize	Jun 01–Dec 08
Uganda	Mbale	Maize	Mar 01–Sep 06
Zambia	Chipata	Maize	Jul 03–Dec 08
Zambia	Choma	Maize	Jul 03–Dec 08
Zambia	Kabwe urban	Maize	Jul 03–Dec 08
Zambia	Kasama	Maize	Jul 03–Dec 08
Zambia	Kitwe	Maize	Jul 03–Dec 08
Zambia	Lusaka	Maize	Jul 03–Dec 08
Zambia	Mansa	Maize	Jul 03–Dec 08
Zambia	Mongu	Maize	Jul 03–Dec 08
Zambia	Solwezi	Maize	Jul 03–Dec 08

Sources: Ethiopia: Ethiopia Grain Trading Enterprise. Ghana: West Africa Agritrade Network. Kenya: Ministry of Agriculture and Regional Agricultural Trade Intelligence Network. Malawi: FEWS-NET. Mozambique: FEWS-NET. South Africa: SAFEX. Tanzania: FEWS-NET. Uganda: Regional Agricultural Trade Intelligence Network. Zambia: FEWS-NET.

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