Transmission of World Food Price Changes to African Markets and its Effect on Household Welfare

Nicholas Minot[1]

5 January 2010

Paper to be presented at the Comesa policy seminar
"Food price variability: Causes, consequences, and policy options"
on 25-26 January 2010 in Maputo, Mozambique
under the Comesa-MSU-IFPRI African Agricultural Markets Project (AAMP)

[1] Senior Research Fellow, Markets, Trade, and Institutions Division. International Food Policy Research Institute, Washington, DC. Contact: n.minot@cgiar.org.

Acknowledgements

This study was funded by the Policy and Research Division of the Department for International Development (DfID) of the United Kingdom, with additional funding from the World Bank through the Comesa-MSU-IFPRI African Agricultural Markets Project. The author would like to thank Patricia Bonnard of FEWS-NET (funded by USAID) 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.

Table of contents

1. Introduction 1
2. Background 3
2.1. Trends in international markets 3
2.2. Transmission of world prices to domestic markets 5
2.3. Impact of food price changes on household welfare 9
3. Data and methods 12
3.1. Price data 12
3.2. Analysis of price transmission 12
3.3. Household survey data 14
3.4. Analysis of household welfare impact 14
4. Results 17
4.1. Trends in staple food prices in sub-Saharan Africa 17
4.2. Econometric analysis of price transmission 22
4.3. Impact of higher food prices on household welfare 30
5. Summary and conclusions 42
5.1. Staple food price trends in sub-Saharan Africa 42
5.2. Econometric analysis of food price transmission from international to African markets 42
5.3. Distributional effect of higher food prices in Ghana 44
5.4. Policy implications of the findings 45
5.5. Future directions in research 46
References 48
Appendix A: Characteristics of price data used in econometric analysis 51

List of tables

Table 1. Changes in East African food prices from June 2007 to June 2008 18
Table 2. Changes in southern African food prices from June 2007 to June 2008....... 19
Table 3. Changes in West African food prices from June 2007 to June 2008....... 20
Table 4. Summary of food price increases by country....... 21
Table 5. Summary of food price increases by commodity....... 22
Table 6. Descriptive statistics of the domestic price data 23
Table 7. Descriptive statistics of international price data....... 24
Table 8. Transmission of world food prices to domestic markets in Ethiopia, Kenya, and Uganda.... 25
Table 9. Transmission of world food prices to domestic markets in Tanzania....... 25
Table 10. Transmission of world food prices to domestic markets in Malawi 26
Table 11. Transmission of world food prices to domestic markets in Zambia 26
Table 12. Transmission of world food prices to domestic markets in Mozambique....... 27
Table 13. Transmission of world food prices to domestic markets in South Africa 27
Table 14. Transmission of world food prices to domestic markets in Ghana....... 28
Table 15. Summary of price transmission by country....... 29
Table 16. Summary of price transmission by commodity....... 29
Table 17. Net position in maize of different types of households in Ghana....... 33
Table 18. Impact on poverty in Ghana of maize price increases of 2007-08....... 34
Table 19. Net position in rice of different types of households in Ghana 36
Table 20. Impact on poverty in Ghana of rice price increases of 2007-08 37
Table 21. Net position in food of different types of households in Ghana....... 40
Table 22. Impact on poverty in Ghana of food price increases of 2007-08....... 41

List of figures

Figure 1. Trends in commodity prices over 2000-2009 3
Figure 2. Net imports of maize and rice as a percentage of apparent consumption for selected African countries....... 29

List of abbreviations

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 which 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
ECM	Error-correction model: an econometric model for estimating the relationship over time between two or more variables characterized by a random walk pattern and delayed effects on each other
FAO	Food and Agriculture Organization
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
NBR	Net benefit ratio: the ratio of net sales of a commodity to household income
SAFEX	South African Futures Exchange: A commodity exchange based in South Africa that organizes trading in futures of agricultural commodities such as maize.

1. Introduction

The global food crisis of 2007-08 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%. 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%. 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% higher than the average level in 2006 (FAO, 2009).

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 level 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 50-70%. 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, 2008).

The goal of this report is to examine the impact of the global food crisis on sub-Saharan African countries. In particularly, we focus on two questions:

- To what degree have changes in the international prices of staple foods been transmitted to domestic markets in sub-Saharan Africa?
- What is the impact of the changes in domestic prices on different types of households in the region?

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 in 2007-08 and compare it them to increase 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.

The distributional impact of food price changes will be estimated based on a simulation of the impact of staple food price changes on each household in a nationally-representative household surveys of Ghana. This analysis is not based on surveys carried out before and during the food crisis; such survey data are not available, and, in any case, they would be influenced by changes other than the high food prices. Instead, we simulate the effect of higher staple food prices on the real income of households, making use of information on the importance of staple foods in their household spending and on the role of staple food sales as a source of income. The data and methods used in this study are described in more detail below.

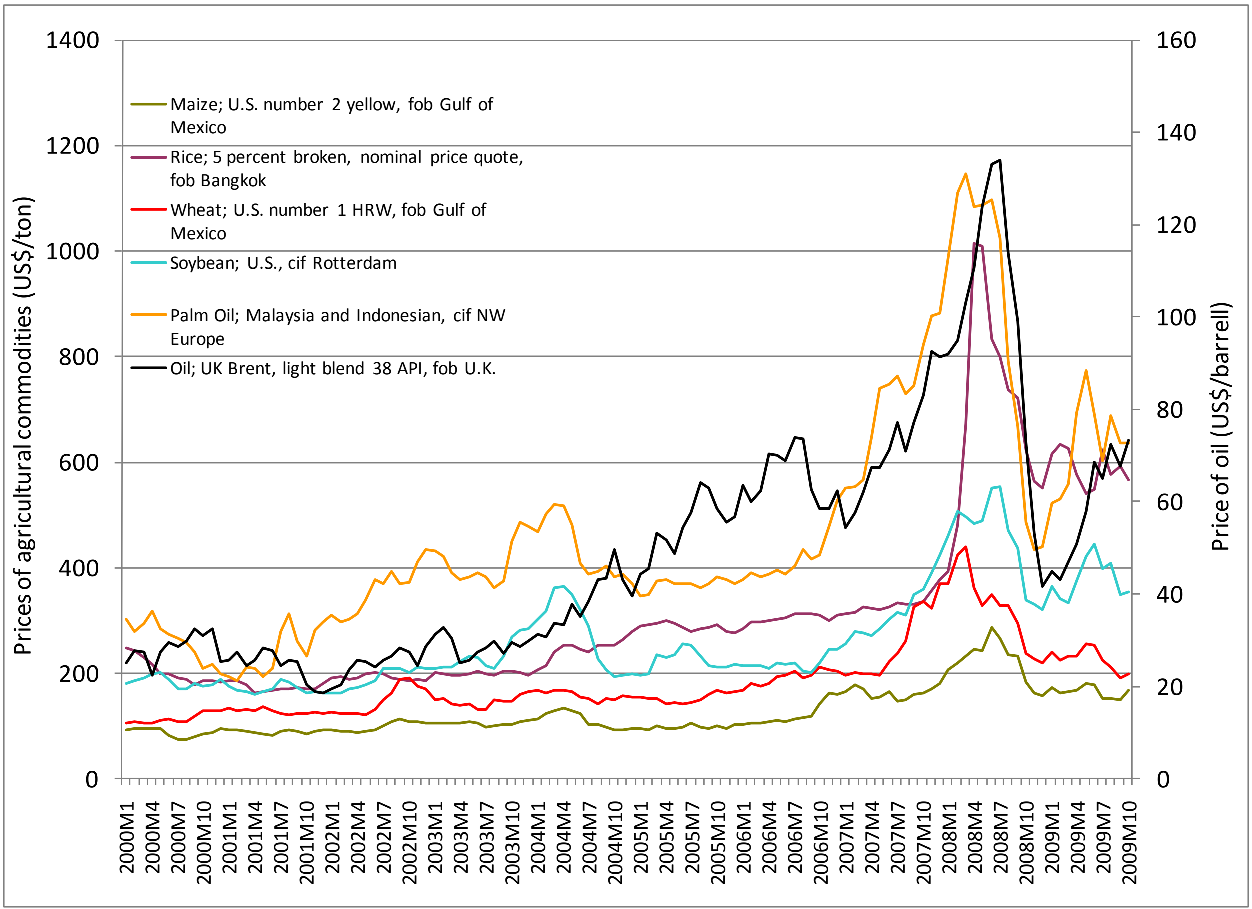
Section 2 provides a descriptive background of the causes and consequences of the global food crisis. Section 3 describes in more detail the data and methods used in this study. Section 4 presents the results of the analysis, and Section 5 summarizes and provides some discussion.

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 remain above the levels of 2006. For example, the price of 5% broken Thai rice was US$ 566 per ton in October 2009 compared to around US$ 330 per ton in mid-2007.

Figure 1. Trends in commodity prices over 2000-2009



Source: IMF, 2009.

The sharp increases in food prices were catalyzed by various factors including the rising cost of oil, biofuel subsidies in the US and Europe, the depreciation of the US 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/barrel in 2003 to over US$ 140/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% of U.S. maize supply was used to supply ethanol processors. Studies by the Council of Economic Advisors and by the International Food Policy Research Institute (IFPRI) estimate that the growth of biofuel production explains about 33-39% of the rise in maize prices (Lazear, 2008; Rosegrant, 2008). By displacing acreage in wheat and soybeans, the growth in maize production for ethanol also 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 U.S. 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 13%. This represented roughly one-quarter of the 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 since January 2006, the dollar prices would have increased 31%. This implies that depreciation of the US dollar explains 15-27% of the increase in dollar-denominated food prices over this period.

Finally, the trade policy 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 5-10 year period of disequilibrium, in which the growth in cereal demand outpaced the growth in cereal production. Cereal demand has been growing at 2% 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 2-5% in the 1970s and 1980s to 1-2% since the mid-1990s (World Bank, 2008). 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 crisis, the stock-to-use ratio for grains was 13%, the lowest ratio since 1960 (Schnepf, 2008).

Many observers have blamed speculation, arguing that investors, looking for high returns, poured money into commodities futures markets in expectation of continued price increases. 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

---

[2] The biofuels mandate establishes a minimum level of biofuel production each year, set at 9 billion gallons in 2008. The tariff on imported ethanol is 54¢/gallon plus 2.5%. The subsidy is in the form of a tax credit worth 51¢/gallon.

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 for which speculators do not have easy access, such as edible beans, durum wheat, rice, and fluid milk[3]. To date, the evidence that speculation 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 expanding output. The global cereal harvest in 2008 was a record 2.3 billion tons, 7 percent higher than the 2007 cereal harvest (FAO, 2009a). Second, the price of oil peaked at around US$ 140/barrel in June and July 2008 and began to fall sharply in August as the global recession dampened the demand. By the end of the year, the price of oil had fallen to US$ 41/barrel, sharply reducing the demand for ethanol and other bio-fuels. In addition, 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 wheat, maize, and rice in the first half of 2009 are still 24-97% higher than the averages in 2006, in spite of the global recession. Furthermore, oil prices have been rising since the beginning of the year, as have maize and soybean prices. 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 have 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 1% change in the price in another market. Although the markets could be for related commodities (e.g. maize and soybeans) or for products at different points in the supply chain (e.g. 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.

[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.

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 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 often 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 dominates 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 between the time a trader decides to import grain from overseas and 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 large 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 food crops. The low value-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 over 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.

[4] The value-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 and/or volume), the cost of transporting will be a larger percentage of the final value for a good with a low value-bulk ratio (such as maize) than for a good with a high value-bulk ratio (such manufactured goods).

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 premia, and normal profits, then trade will be profitable. In other words, if

$$P_B{}^a - P_A{}^a > c$$

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 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:

$$P_B - P_A = c$$

where

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

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 US$300/ton and the domestic price of rice in Ghana is US$ 600/ton, and a US$60 increase in the world price results in a US$ 60/ton increase in the local price, the elasticity of price transmission from the world price to the domestic prices 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:

$$P_A + c > P_B > P_A - c$$

And as long as there is no trade, there will be no price transmission. 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 larger if the distance between them is large, if transportation infrastructure is poor, if tariffs and other trade taxes are high, and if trading is particularly risky.

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 them.

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 analyzing the relationship between world market prices and domestic prices in sub-Saharan Africa, there is a large difference in scale. We can often 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, Cote d’Ivoire is one of the larger rice importers in sub-Saharan Africa, but its imports of 10 thousand tons per year represent just 0.04% of the 25 million tons of rice traded on world markets. Thus, it is unlikely that changes in Ivoirian prices or imports will have any measurable impact on world rice prices. Similarly,

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

although South Africa exported 1.0 million tons of maize in 2006, this was barely 1% 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:

$$P_W + c \geq P_A \geq P_W - c$$

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 to the world price after deducting transportation costs. As described above, a large 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 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. There is a large number of studies that 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; Kuiper et al, 2006 for Benin; Meyers, 2008 for Malawi; Negassa and Meyers, 2007 for Ethiopia; van Campenhout, 2007 for Tanzania; and Moser et al, 2009 for Madagascar). Here, we focus on the smaller number of 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) estimate the transmission of world food prices to domestic prices in 58 countries using annual price data from the FAO. They find very high rates of price transmission: the median elasticity of transmission was 0.95, implying that 95% 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; Timmer, 1987).

In the 1980s, researchers became aware of the problem of non-stationarity. 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 non-stationary, 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 non-stationary 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 non-stationary 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 non-stationary 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 non-stationary variables may related to each other by a long-term relationship, even if they diverge in the short-run. If two non-stationary variables move together in the long run, they are said to be co-integrated[6]. In this case, an error-correction model (ECM) is appropriate to deal with the problems of dynamic effects and non-stationarity, 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. They found no relationship between domestic and international prices for 30 of the 78 countries examined, and even in countries with a relationship, the convergence was very slow in many of them.

Conforti (2004) examined price transmission in 16 countries , including three 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 into account non-stationarity 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), transaction 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 auto-regressive (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 together when the difference exceeds that threshold (von Campenhout, 2007; Meyers, 2008).

2.3. Impact of food price changes on household welfare

The second objective of this report is to assess the impact of the price changes associated with the commodity price spike of 2007-08 on different types of households in sub-Saharan Africa. This section provides a conceptual framework for understanding the impact of food price changes on household welfare, as well as a review of previous research.

Conceptual framework

Food prices affect household both as consumers of food and producers, but for our purposes it is useful to separate these two effects. For a household that consumes a good but does not produce it, the welfare impact of a price change can be measured using the consumer surplus (CS). An

[6] In technical terms, co-integration refers to the situation where there exists a linear combination of non-stationary variables yields a stationary variable, for example $P_A - \beta P_B = \varepsilon$, where P_A and P_B are non-stationary variables, β is a coefficient, and ε is a stationary error term.

approximate measure of consumer surplus is based on the size of the price change and the initial level of consumption of the good in question. This measure does not require information on the price elasticity of demand, that is, the degree to which consumers reduce consumption of the good when its price rises. However, this measure is only accurate for small price changes or when the consumers are not very responsive to price changes in the good. A better measure of consumer surplus takes into account the price elasticity of the good. The larger the price elasticity, the smaller the welfare impact of a given price increase, reflecting the fact that consumer welfare is less adversely affected by a price increase when they can switch to substitute goods in response (see Section 3.4 for the equations used to calculate consumer surplus).

For a household that produces a good but does not consume it, the welfare impact can be measured using the producer surplus. Again, an approximation of producer surplus is based only on the size of the price change and the revenue the household initially makes from the good. A more accurate measure also takes into account the price elasticity of supply, that is, the degree to which producers expand output in response to a price increase. In the case of producers, a large supply elasticity makes the welfare effect of a price increase even larger, because it implies that farmers can take advantage of the higher price to expand output (see Section 3.4 for the equations used to calculate producer surplus).

Of course, many households in developing countries are both producers and consumers of food. In this case, the net welfare impact is the sum of consumer surplus and producer surplus. If the household is a net buyer of the commodity, it will lose from higher prices and gain from lower prices. If it is a net seller, the reverse holds. If the household is self-sufficient, neither buying nor selling the commodity, then it is unaffected by small changes in price, though a large change may induce it to begin buying or selling, resulting in a welfare gain.

Urban households in developing countries are almost always net buyers, with poor urban household allocating a larger share of their income to food in general and staple foods in particular. Thus, the relative impact of higher food prices is adverse for almost all urban households but more so for poor urban households. For rural households in developing countries, the situation is more complicated. Larger farms are more likely to be net sellers, so they gain from higher prices. Small farmers are often net buyers of staple food crops, relying on income from remittances, the sale of labor, or income from micro-enterprises to cover the cost of food purchases. Studies in sub-Saharan Africa indicate that in many cases more than half of rural households are net buyers of individual food crops (Weber et al, 1988; Barrett and Dorosh, 1996; and World Bank, 2008).

Once the welfare effect of a given price change has been calculated for each household in the sample, it is possible to aggregate the results to calculate changes in income or the poverty rate for the country as a whole or any subset of households.

Previous research on the welfare impact of food price changes

Deaton (1989) defined the net benefit ratio (NBR) as the ratio of a household's net sales of a commodity to household income. He showed that the NBR is the short-run elasticity of welfare impact with respect to a commodity price change and used the NBR of rice in Thailand to simulate the impact of rice price changes on income distribution. Since then, this approach has been widely used to estimate the distributional impact of food price changes in developing countries (see Budd, 1993; Barrett and Dorosh, 1996; Minot and Goletti, 2000; Ivanic and Martin, 2008). Here, we focus on recent studies on the impact of food price changes in sub-Saharan Africa.

Ivanic and Martin (2008) examine the welfare impact of higher food prices on households in nine developing countries using both hypothetical price increases (10%) and historical increases in world prices over 2005-07. A 10% increase in maize prices lowers poverty in four countries, increases poverty on another four, and has no effect on one. In Malawi and Zambia, 10% higher maize prices increased poverty by 4 percentage points, the most adverse impact among the nine countries under consideration. This is a reflection of dominance of maize in the diet in these two countries. In Madagascar, a 10% increase in maize prices also increased poverty, but only by 0.2 percentage points. In contract, a 10% increase in rice prices had small effects on households in Malawi and Zambia, increasing poverty by 0.0 and 0.1 percentage points, respectively, but a larger effect on household in Madagascar, increasing poverty by 2.5 percentage points. In all three countries, the adverse impact was greater for rural than urban households, reflecting the large number of poor net buyers in rural areas of these countries. The analysis also estimated the impact of the likely increase in unskilled wages as a result of higher food prices. In all three African cases, the wage effect partially offset the increase in poverty due to the higher food prices.

Arndt et al (2008) estimates the impact of higher food prices on poverty in Mozambique. Because the survey does not disaggregate agricultural sales by commodity, the simulation is for changes in all food prices. They estimate that a 10% increase in food prices would raise rural income by 1.0% and reduce urban income by 2.2%.

Wodon and Zaman (2008) estimate the impact of higher food prices on the poverty rates in ten countries of Central and West Africa. They estimate that a 50% increase in food prices increases the national poverty rate by 2.5 percentage points, taking into account both changes in consumer prices and farm income. There is considerable variation across countries, however: the increase in poverty ranges from around 1 percentage point in Nigeria and Ghana to over 5 percentage points in Liberia and Niger. The impact is greater in Liberia and Niger because these countries are heavily dependent on food imports, with relatively few surplus farmers. In addition, these countries have relatively high poverty rates, which implies that a significant portion of the population is near the poverty line and vulnerable to falling below it.

Other studies focus on the impact of higher food prices on food consumption. Cudjoe, Beisinger, and Diao (2008) carry out a demand analysis using survey data from Ghana and use the results to estimate the impact of historical food price increases on consumption of staple food consumption. In urban areas, grain and root consumption is estimated to fall 9%, with greater reductions among the urban poor. In rural areas, grain and root consumption falls by 7% without any strong pattern by income group. It should be noted that this analysis did not take into account the effect of changes in farm income as a result of the higher food prices, which would partially offset these reductions in food consumption.

Similarly, Ulimwengi, Workneh, and Paulos (2009) estimate a demand system using survey data from Ethiopia. From the results, they calculate the impact of a 50% increase in grain prices on caloric intake. The results suggest that urban caloric intake declines by 16% while rural caloric intake declines by 24%. As in the previous study, these results do not consider the impact of higher grain prices on the income of farmers, so they may overstate the adverse impact of food price increases.

Ulimwengi and Ramadan (2009) use an estimated demand system for Uganda to simulate the impact of a 50% increase in cereal prices. Taking into account both the effect on the income of farmers and the prices faced by consumers, they estimate that cereal consumption would decline 29-37%, depending on the region.

In summary, most studies conclude that higher food prices lower real income and increase poverty in sub-Saharan Africa. Somewhat surprisingly, higher food prices increase poverty not only in urban areas, but also in rural areas, where a significant proportion of the poor are net buyers of staple foods.

3. Data and methods

In describing the data and methods used in this study, we separate the price transmission analysis and the household survey data analysis. In the first part of the analysis, we use 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. In the second part of the analysis, we use household survey data for Ghana to explore the impact of domestic price changes on the real income of different types of households. The data and methods for this component are described in sections 3.3 and 3.4, respectively.

3.1. Price data

The descriptive analysis of price trends over 2007-08 uses 83 monthly price series for staple food crops from twelve countries in sub-Saharan Africa, compiled by FAO (2009b). These prices have already been converted to US 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 A1 and 62 price series from nine sub-Saharan African countries shown in Table A2 (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 ten African countries were obtained from the International Financial Statistics database maintained by the International Monetary Fund (IMF). The IMF exchange rates were used to convert all African prices to current US dollar prices. The US dollar equivalent of the African domestic prices and the US dollar world prices were converted to real US dollars at 2008 prices using the US consumer price index, obtained from the Bureau of Labor Statistics.

3.2. Analysis of price transmission

This study uses the vector error-correction model (ECM) 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 vector error-correction model is appropriate if two conditions are met:

- Each variable is non-stationary 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).
- The variables are co-integrated, meaning that there is a linear combination of the variables that is stationary. We are analyzing two prices at a time, so that the co-integrating 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:

- First, 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.

- Second, we use the Johansen test to determine whether the two series are co-integrated, meaning that each variable is I(1) and a linear combination of the two variables is I(0). In terms of our analysis, the test whether there is a long-run relationship between the domestic price and the corresponding world price.

- Third, if the Johansen test indicates that there is a long-run relationship between the two variables, then we estimate the vector error-correction model (ECM). The model takes the following general form:

$$\mathbf{\Delta p_t} = \boldsymbol{\alpha} + \mathbf{\Pi p_{t-1}} + \sum_{k=1}^{q} \mathbf{\Gamma_k}\, \mathbf{\Delta p_{t-k}} + \boldsymbol{\varepsilon_t}$$

where $\mathbf{p_t}$ is an nx1 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 nx1 vector of error terms, and
$\boldsymbol{\alpha}$ is an nx1 vector of estimated parameters that describe the trend component
$\mathbf{\Pi}$ is an nxn matrix of estimated parameters that describe the long-term relationship and the error correction adjustment, and
$\mathbf{\Gamma_k}$ is a set of nxn matrices of estimated parameters that describe the short-run relationship between prices, one for each of q lags included in the model.

The vector error-correction model 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 food crop 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 only interested in one portion of the VECM. This portion can be simplified as follows:

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

where p_t^d is the log of domestic price converted to real US dollars
p_t^w is the log of world price of the same commodity in real US dollars
Δ is the difference operator, so $\Delta pt = pt - pt-1$
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 , then the co-integration 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% 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 represent the deviation or "error" between the prices in the previous period and the long-run relationship between the two prices. If the error is positive (the domestic price is too high given the long-term relationship), then the negative value of θ helps "correct" the error by making it more likely that the Δp^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 1% 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 of many vector error-correction models, but it is less important when examining the transmission of international prices to domestic prices. This is because the causality from domestic to international prices is implausible.

3.3. Household survey data

In order to examine the impact of food price changes on different types of households, we need household survey data. In this analysis, we make use of the 2005-06 Ghana Living Standards Survey. Although it was conducted before the global food crisis, it provides information on the income and spending patterns of different types of households which we use to infer the impact of higher food prices.

The Ghana Living Standards Survey (GLSS) is a multi-topic household survey. The objective of the survey was to collect information on various dimensions of living conditions, such as education, health and employment. These data were collected on a countrywide basis. Five rounds of the GLSS have been completed so far: 1987-88, 1988-89, 1991-92, 1998-99 and 2005-06. In this report we only focus on the most recent one, the 2005-06 GLSS or GLSS5. The questionnaire contained 12 modules covering information on the demographic characteristics of household members, education, health, employment, migration, housing, agriculture sources of income, expenditures, non-farm activity, income transfers, and credit and savings. The length of questionnaire was 127 pages. The field work was implemented over 12 months, between September 2005 and September 2006.

The survey was conducted by the Ghana Statistical Service (GSS) in collaboration with the World Bank. The GSS maintains a complete list of Census enumeration areas (EAs), together with their respective population and number of households as well as maps, with well-defined boundaries, of the EAs. This information was used as the sampling frame for the GLSS5. A two-stage stratified random sampling design was adopted:

- In the first stage, 580 enumeration areas were selected
- In the second stage, 15 households in each enumeration area were selected.

This design yielded a total sample of 8,700 households. At the end of the survey 8,687 households were successfully interviewed.

3.4. Analysis of household welfare impact

As described above, this study measures the welfare impact of price changes on households using measures of the consumer surplus and producer surplus. We start with an estimate of the change in price for a staple food commodity and information on the income and consumption patterns of a sample of households. Consumer surplus (CS) is an approximate measure of the welfare impact of a price change on a household that consumes but does not produce the good[7]. For an individual household, a first-order approximation of the consumer surplus associated with the change in price of a good is:

[7] Consumer surplus is an approximate measure of equivalent variation and compensating variation. These two exact measures are computationally difficult to estimate and do not provide additional accuracy given the level of uncertainty regarding the price elasticity of demand.

$$CS \cong -q_{d1}(p_2 - p_1) = -q_{d1}(\Delta p)$$

where q_{d1} is the quantity demanded before the price change, p_1 and p_2 are the prices before and after the change, and Δ refers to the change in a variable. This first-order approximation does not take into account the response of consumers to the price change and may be considered the very-short-term impact.

The second-order approximation of consumer surplus, which does take into account consumer response, can be expressed as:

$$CS = -0.5(q_{d1} + q_{d2})(p_2 - p_1) = -q_{d1}(\Delta p) - 0.5(\Delta p)(\Delta q_d)$$
$$= -q_{d1}p_1\frac{\Delta p}{p_1} - 0.5\varepsilon_d q_{d1}p_1\left[\frac{\Delta p}{p_1}\right]^2$$

where q_{d1} and q_{d2} are the quantities demanded before and after the price change and ε_d is the price elasticity of demand. Because the price elasticity of demand is negative, the second term in this expression is positive.

Next, we can write the proportional welfare impact as the consumer surplus as a proportion of income:

$$\frac{CS}{Y} = -(CR)\frac{\Delta p}{p_1} - 0.5\varepsilon_d(CR)\left[\frac{\Delta p}{p_1}\right]^2$$

where Y is household income, CR is the consumption ratio, defined as the value of the consumption of the commodity as a proportion of total income, and ε_d is the price elasticity of demand.

The second-order approximation of the producer surplus (PS) is similar:

$$PS = q_{s1}p_1\frac{(\Delta p)}{p_1} + 0.5\varepsilon_s q_{s1}p_1\left[\frac{\Delta p}{p_1}\right]^2$$

except that the signs are positive. This is because a price increase has a positive effect on the welfare of a producer. By the same transformation as above, we can write the producer surplus as a proportion of income.

$$\frac{PS}{Y} = (PR)\frac{\Delta p}{p_1} + 0.5\varepsilon_s(PR)\left[\frac{\Delta p}{p_1}\right]^2$$

where PR is the production ratio, defined as the ratio of income from the commodity to total income, and ε_s is the price elasticity of supply.

We can combine these two equations to get the net welfare impact on a household as both producer and consumer:

$$\frac{PS + CS}{Y} = (PR)\frac{\Delta p}{p_1} + 0.5\varepsilon_s(PR)\left[\frac{\Delta p}{p_1}\right]^2 - (CR)\frac{\Delta p}{p_1} - 0.5\varepsilon_d(CR)\left[\frac{\Delta p}{p_1}\right]^2$$
$$= (NBR)\frac{\Delta p}{p_1} + 0.5\varepsilon_s(PR)\left[\frac{\Delta p}{p_1}\right]^2 - 0.5\varepsilon_d(CR)\left[\frac{\Delta p}{p_1}\right]^2$$

where NBR is the net benefit ratio, defined as PR-CR. In the second line, the first term is the first-order approximation of the impact of the price change on net welfare, which can be interpreted as the short-run impact before households have an opportunity to respond to the price change. The second and third terms adjust the welfare measure for the household's response to the price change, taking into account the price elasticity of supply and of demand. Thus, the full expression on the second line can be interpreted as the long-run impact, after households have an opportunity to respond to the price change. With estimates of the welfare impact of a price change on each household, we can then aggregate the results to a set of households (such as rural households or maize farmers) to calculate the change in average income or the change in the poverty rate associated with the price change.

In this study, we simulate the impact of the historical nominal price changes over the period June 2007 to June 2008 on the incidence of poverty in Ghana. Separate simulations are carried out for the prices increases in maize, rice, and food in Ghana.

The two main sources of uncertainty in these estimates are 1) the appropriate supply and demand elasticities to use and 2) the relationship between producer and consumer prices. Regarding the elasticities, most studies of this type assume no household response (see Deaton, 1989; Ivanic and Martin, 2008; and Wodon and Zaman, 2008). However, in the longer run, households may be able to respond both as consumers and as producers, though price elasticities for staple foods are generally low. In this study, the base simulation assumes no household response (zero elasticities), which corresponds to the short run impact. We also provide long-run estimates assuming own-price demand elasticities of -0.3 and supply elasticities of 0.3.

The second issue is the relationship between consumer prices and producer prices. It is rarely possible to obtain both producer and consumer price data, particularly in sub-Saharan Africa. The simplest assumption, and the one generally adopted in this type of study, is that both prices increase in the same proportion, equivalent to assuming a marketing margin that is a fixed proportion of the consumer price. However, it could be argued that it is more plausible to assume a fixed marketing margin, which implies that the percentage increase in producer prices will be greater than the percentage increase in consumer prices. Dawe and Matsoglou (2009) argue that the estimation of the welfare impact of price increases is sensitive to assumptions about the marketing margin. If the consumer price is twice the producer price and the margin is fixed in absolute terms, the percentage increase in the producer price will be twice the percentage increase in the consumer price. In this study, we provide separate estimates based on these two alternative assumptions. Thus, for each commodity, we provide four estimates of the impact of higher prices:

- The base assumption is that households do not respond to higher prices and that producer and consumer prices rise by the same percentage (implying a fixed percentage marketing margin).
- In simulation 2, we assume that households do not respond to higher prices and that the percentage increase in producer prices is twice the percentage increase in consumer prices.
- In simulation 3, we assume household response to price changes (a demand elasticity of -0.3 and a supply elasticity of 0.3) and equal percentage increases in producer and consumer prices.
- In simulation 4, we assume household response to price changes and that producer prices rise twice as much in proportional terms as consumer prices.

4. Results

The results are divided in three 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 2007-08. Section 4.2 uses time-series econometrics to analyze the relationship between domestic and international prices in the longer term for 62 prices in nine African countries. And Section 4.3 focuses on the impact of the food price increases on different types of households in Ghana.

4.1. Trends in staple food prices in sub-Saharan Africa

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

The second column of figures indicates the change in domestic prices as a percentage of the change in the corresponding international prices. Thus, 100% 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 the purchase of foreign exchange, thus suppressing the depreciation. Over June 2007 to June 2008, prices rose about 70% but the exchange rate remained essentially unchanged. In addition, a supply shock may be contributing to higher real prices (see Loening et al, 2008 and Dorosh, 2008).

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

Table 1. Changes in East 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	Maize	Wholesale	184%	236%
	Addis	Teff	Wholesale	100%	111%
	Addis	Wheat	Wholesale	83%	141%
	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: FAO (2009b).

In the other East African countries, the proportional change in domestic prices was less than the proportional change in the corresponding international price. The percentages appears to be lower for beans than for maize and rice, perhaps reflecting the fact that it is a non-tradable commodity.

Food prices followed a similar pattern in southern Africa (see Table 2). Across the 21 prices examined, the average increase (in US$ terms) between June 2007 and June 2008 was 107%. The highest price increases were in Malawi: six of the nine prices examined in the country increased by more than 150%. 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 40-60%, significantly less than in Malawi. This difference is somewhat surprising given than Malawi lies in 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% in dollar terms between June 2007 and June 2008, while wheat prices increased just 32%. There were no unusual movements in the rand-dollar exchange rate which would explain this low rate of increase in food prices. South Africa is a major regional exporter of maize, exporting 470 thousand tons of maize in 2007-08. 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	Johanesburg	Wheat	Wholesale	32%	54%
	Johanesburg	White maize	Wholesale	7%	9%
	Johanesburg	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: FAO (2009b).

In West Africa, the food prices appear to have increased somewhat less than in southern and East Africa (see Table 3). Across the 42 prices examined, the average increase over the period from June 2007 to June 2008 was 42%, compared to 76% in East Africa and 86% 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%. In contrast, the price increases for rice and maize tend to be in the range of 40-80%. The results show some interesting contrasts. For example, the price of rice increased just 4% in Accra (Ghana), but rose 132% in Dakar (Senegal). Similarly, maize prices increased more than 80% in Accra, but less than 20% in several markets in Cameroon. Rice is imported in significant volumes by most West African countries, so we hypothesize 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 West 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% of the increase in the corresponding world prices. In most cases, the percentage was less than 60%. One notable exception is the price of maize in Accra, which was slightly greater (105%) than the increase in maize prices on the world market over the same period.

Table 3. Changes in West 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	Wheat flour	Retail	30%	51%
Ghana	Accra	Cassava	Retail	8%	9%
	Accra	Maize	Retail	82%	105%
	Accra	Rice	Retail	4%	3%
Mali	Bamako	Millet	Wholesale	52%	75%
	Bamako	Rice	Wholesale	71%	46%
	Kayes	Millet	Wholesale	36%	52%
	Kayes	Rice	Wholesale	61%	40%
Senegal	Dakar	Rice	Retail	132%	87%
	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	Rice	Retail	58%	38%
	Saint Louis	Rice	Retail	31%	20%
	Tambacounda	Rice	Retail	54%	35%
	Thies	Rice	Retail	83%	54%
	Zguinchor	Rice	Retail	67%	44%
	Dakar	Millet	Retail	41%	59%
	Matam	Millet	Retail	45%	65%
	SaintLouis	Millet	Retail	41%	59%
	Dakar	Sorghum	Retail	29%	42%
	Matam	Sorghum	Retail	32%	46%
	Saint Louis	Sorghum	Retail	41%	59%
Average				45%	42%

Source: Calculations based on price data from FAO (2009c).

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%, which is 71% of the price increase of the corresponding commodities in world markets. As discussed above, Malawi and Ethiopia have experienced the sharpest increases in staple food crop prices over the reference period. In both cases, the average price increase was more than 100%, 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 are South Africa (25%), Cameroon (32%) and Ghana (39%).

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: Calculated based on data from FAO (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%), while all coastal countries except Mozambique had food price increases below this average. However, it is difficult to develop a convincing explanation of this result. Landlocked countries face higher transportation costs to the ports, so the gap between import parity and export parity prices is larger than for coastal countries. This implies that imported food crops will have higher prices in landlocked countries, and that fluctuations in domestic supply will result in wider variation in domestic prices. But a rise in world price would 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 the initial import parity price is higher.

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 CIF prices of imported food and higher costs of overland transport.

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%), wheat (65%), and rice (62%). The smallest increases occurred in plantains (9%), cassava (12%), and beans (41%). 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 non-tradable 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 for 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: Calculated based on data from FAO (2009b).

These results should be interpreted with some caution, however. We have only a few price series available for some countries (e.g. three each for Ghana, Rwanda, South Africa, Tanzania, and Zambia) and for some commodities (e.g. 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 food crops 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. For each domestic price, we estimate a vector error-correction model that combines a food price from sub-Saharan Africa (converted to US 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, there are several notable patterns. First, African prices for the staple grains 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 US$ 210/ton, but the average price of rice in Ghana varies from US$ 334 to US$ 734, depending on the location. Similarly, the average world price of maize is US$ 121/ton, but the average maize price in different markets in Mozambique ranges from US$ 177 to US$ 285. Finally, the average world price of wheat is US$ 167, but the Ethiopian wheat price averages US$ 261/ton. The only exceptions are the price of maize in Kampala (Uganda), which averaged 24% 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
	Tamale	Imported rice	45	334	243	650	82
	Techiman	Imported rice	48	341	224	491	76
	Kumasi	Local rice	48	734	412	832	117
	Tamale	Local rice	46	438	310	528	56
	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
	Gorongosa	Maize	69	177	84	619	111
	Maputo	Maize	69	285	183	529	87
	Nampula	Maize	69	212	109	454	90
	Tete	Maize	69	201	102	621	112
	Chokwe	Rice	69	414	241	783	96
	Gorongosa	Rice	69	533	326	1176	195
	Maputo	Rice	69	472	250	814	144
	Nampula	Rice	69	502	274	1060	208
	Tete	Rice	69	657	339	1157	195
South Africa	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
Tanzania	Arusha	White maize	60	182	104	547	81
	Dar es Salam	White maize	60	180	99	503	75
	Mbeya	White maize	60	135	79	282	44
	Arusha	Maize	60	170	108	293	44
	Dar es Salam	Maize	60	171	114	271	44
	Mtwara	Maize	60	183	75	381	65
	Singida	Maize	60	170	92	302	51
	Songea	Maize	60	121	69	308	45
	Arusha	Rice	60	513	271	897	106
	Dar es Salam	Rice	60	512	295	746	102
	Mtwara	Rice	60	519	340	750	97
	Singida	Rice	60	488	269	785	106
	Songea	Rice	60	416	172	621	84
	Dar es Salam	Sorghum	60	264	147	657	91
	Mtwara	Sorghum	60	258	174	383	50
	Singida	Sorghum	60	174	103	286	50
Uganda	Kampala	Maize	93	92	32	229	39
	Mbale	Maize	69	130	51	199	38
Zambia	Chipata	Maize	68	207	119	376	67
	Choma	Maize	68	173	99	334	62
	Kabwe Urban	Maize	68	194	97	458	73
	Kasama	Maize	68	192	97	380	73
	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

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: FAO, 2009b

Note: Rice price refers to Thai Super A1 broken white rice, FOB Bangkok. Maize price refers to US No. 2 yellow maize, FOB Gulf of Mexico. Wheat price refers to US hard red winter wheat, FOB Gulf of Mexico.

There are three likely reasons for the higher prices in Africa.

- First, the cost of seafreight 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.
- Second, the African prices are generally wholesale and retail prices, so they refer to purchases in smaller volumes and include local marketing margins.
- Third, 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 US$ 136/ton, but 470 kilometers up the coast in Maputo, the price of maize is US$ 285/ton. In addition, the price of local rice in Tamale (northern Ghana) is US$ 438, compared to US$ 734 in Kumasi (central Ghana). In both case, it is difficult to imagine that the cost of transportation could explain such large differences.

Turning to the econometric analysis, Table 8 provides a summary of the results for seven prices from three East 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 auto-regressive model using the level of prices (p_t).

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, i.e. 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 lagged terms, the international price has 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 8-9% 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.

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

Table 8. 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)		
Country	Location	Commodity	ADF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
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.

As shown in Table 9, of the eight maize markets in Tanzania, on in Arusha was there a significant long-run relationship with the world price of maize. In this case, about 54% 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 24-54% of the changes in world rice prices are transmitted to Tanzanian markets.

Table 9. 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)		
Country	Location	Commodity	ADF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
Tanzania	Arusha	Maize	No	No	Yes	0.54 *	-0.23	0.54
Tanzania	Dar es Salaam	Maize	Yes	Yes	No			
Tanzania	Mbeya	Maize	No	No	No			
Tanzania	Arusha	Maize	Yes	Yes	No			
Tanzania	Dar es Salaam	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 Salaam	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 Salaam	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.

The results for Malawi are shown in Table 10. 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% level (it is, however, significant at the 10% level). Lilongwe is the capital city and headquarters of 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 10. 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)		
Country	Location	Commodity	ADF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
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.

Table 11 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.

Table 11. 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)		
Country	Location	Commodity	ADF test	Phillips-Perron test	Johansen test	Speed of Adjust-ment	Short-run Adjust-ment	Long-run Adjust-ment
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	No	No	No			
Zambia	Solwezi	Maize	No	No	No			

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

The results of Mozambique are present in Table 12, 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 show a long-run relationship with world rice prices. The long-run elasticity of price transmission is statistically significant in the same four rice markets. The elasticity is relatively high 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 rice price is not co-integrated 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 Mozambique

			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
Mozambique	Beira	Maize	Yes	Yes	No			
Mozambique	Chokwe	Maize	Yes	Yes	No			
Mozambique	Gorongosa	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	Yes	0.37 *	-0.24	0.39 *
Mozambique	Gorongosa	Rice	Yes	Yes	Yes	0.31 *	-0.23	0.16 *
Mozambique	Maputo	Rice	Yes	Yes	No			
Mozambique	Nampula	Rice	Yes	Yes	Yes	0.31 *	-0.24	0.97 *
Mozambique	Tete	Rice	Yes	Yes	Yes	0.30 *	-0.40 *	0.70 *

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

As shown in Table 13, we analyze the relationship between four maize prices in South Africa and world maize prices. The unit root tests confirm that all four prices are non-stationary 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 East African prices. In both one- and two-month lag version of the VAR, world maize prices had no significant effect on South African maize prices.

Table 13. 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	ADF 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 14 shows the results of testing the cointegration of Ghanaian rice prices (in US$) 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 14. 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 ric	No	No	No			
Ghana	Kumasi	Imported ric	Yes	Yes	No			
Ghana	Tamale	Imported ric	No	No	No			
Ghana	Techiman	Imported ric	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.

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 US 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. First, a number of southern and East 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 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 domestic African prices are summarized by country in Table 15. Overall, 13 of the 62 staple food prices tested show a statistically significant long-run relationship with world prices according to the Johansen co-integration test. Malawi, Mozambique, and Ethiopia have the highest proportion of prices that are linked to world markets, though the percentage is less than 40% even in these countries. Zambia, Uganda, South Africa, and Kenya have no prices that show a long-run relationship with world markets.

Table 16 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% for maize. Thus, according to the econometric analysis of prices, rice markets in Africa are generally better connected to world markets than maize markets. This is understandable given the trading patterns in the region. Most sub-Saharan African countries are close to self-sufficient in maize, importing small quantities for special needs or in the event of a poor harvest. In contrast, almost all African countries import a large percentage of their rice requirements.

Table 15. Summary of price transmission by country

	Prices with relationship	Total nbr. of prices	Percen-tage
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: Author's analysis using price data from various sources.

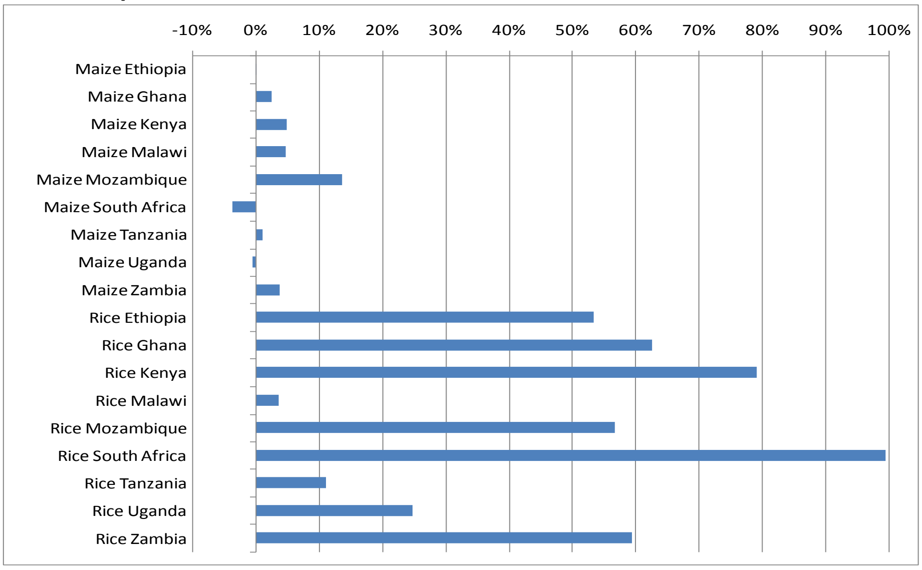
Table 16. Summary of price transmission by commodity

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

Source: Author's analysis using price data from various sources.

Figure 2 shows that most of the countries under consideration are highly reliant on rice imports, which account for more than half of apparent domestic consumption in six of the nine countries. In contrast, maize trade represents no more than 5% of domestic apparent consumption in all but one country (Mozambique is the exception). This difference helps to explain the fact that, in the countries examined, rice prices are more closely tied to world markets than maize prices.

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.

4.3. Impact of higher food prices on household welfare

This section describes the results of simulations of the impact of price increases on different types of households in Kenya and Ghana. As described in sections 3.3 and 3.4, we use household income and expenditure survey data to simulate the impact of food price increases on the real income (or purchasing power) of each household. The results are then aggregated to different types of households, defined by location, income, farm size, and other characteristics.

Welfare impact of higher maize prices in Ghana

The net position in a commodity refers to the net sales or purchases of the commodity for a household or a group of households. The net benefit ratio (NBR) is the value of net sales of a commodity as a percentage of household income. As discussed above, a positive NBR means that a household or group of households will gain from higher prices of the commodity in the short run, while a negative NBR means it will lose. The long run effect will be somewhat less negative or more positive.

Table 17 shows the net position in maize of different types of households in Ghana. The last row in the table shows that, overall, maize accounts for 5% of household income and maize consumption represents 6% of the total. This implies an average NBR of -0.01 or -1%. The negative NBR is a necessary consequence of the fact that Ghana is a net maize importer. However, even if Ghana were self-sufficient in maize, the net benefit ratio would be slightly negative because the NBR is defined in value terms rather than quantity terms, and consumer prices are higher than producer prices. The last three columns indicate the proportion of households in each category that are net sellers, self sufficient, and net buyers. In this context, self-sufficient refers to households with zero net sales, either because they do not grow or consume maize or because they produce maize for own consumption without any maize purchases or sales[10]. Overall, 21% of the households in Ghana are net sellers of maize, 46% are net buyers (including most urban households), and 33% are self-sufficient .

For rural households, maize consumption represents 7% of income, while maize income accounts for 9% of the total. The net benefit ratio is negative, indicating that rural households are hurt by higher maize prices on average. However, the small value, -0.02, suggests that a 10% increase in maize prices would reduce the average welfare of rural households by 0.2%. Maize is less important to urban households, both as a source of income and as a component in their expenditure.

It is not surprising that most urban households are net buyers and few (7%) are net sellers. It is somewhat surprising that among rural households there are more net buyers of maize (39%) than net sellers (31%), but this agrees with results from other African countries (World Bank, 2008). Rural net buyers of maize include households that rely on wage income, small business income, and income from cocoa and other cash crops (see Table 17).

The results also show that female-headed households have a more negative NBR than male-headed households, suggesting they are somewhat more vulnerable to increases in maize prices. According to the survey data, female-headed households are less likely to be net sellers and more likely to be net buyers compared to male-headed households. Nonetheless, the impact of maize price increases on female-headed households is modest: a 10% increase in maize prices would reduce the welfare of female-headed households by 0.3%.

Less than half of Ghanaian households (41%) grow maize. Among these households, maize accounts for 12% of income and is 10% of expenditure, yielding a net benefit ratio of 0.02. About half of the maize growers (51%) are net sellers, 20% grow only for their own consumption, and 29% purchase

[10] In theory, households that buy and sell exactly the same value of maize would also fall in this group, but this is unlikely in practice.

maize to supplement their own harvest. Among households that do not grow maize, the NBR is -0.03, indicating that a 10% increase in maize price would reduce their welfare 0.3% (see Table 17).

Across the 10 administrative regions of Ghana, the Upper West and Upper East regions have the most negative NBRs (-0.09), followed by the Volta region. In all three regions, households that are net buyers of maize account for over 50% of the total. Thus, these are the three regions most adversely affected by an increase in maize prices. The Upper East and Upper West regions are sparsely populated, containing just 4% and 2% of the national population, respectively. However, this is worrisome because the Upper East and Upper West are two of the poorest regions of Ghana. Ashanti, Brong Ahafo, and the Central region have the largest NBRs (0.00 to 0.01), which indicate that they would not be adversely affected by a maize price increase.

The results are also presented by quintile of expenditure per capita. A clear pattern emerges in which poor households are the most dependent on maize production, but also rely more heavily on maize in their consumption basket. The net effect is that the NBR is somewhat more negative for the poorest quintile of households (-0.03) than for the richest (-0.1). This implies that the adverse effect of higher maize prices is greatest on the poor, although the effect is fairly modest in both cases (see Table 17).

Finally, we see that the NBR is closely related to farm size. The importance of maize in income rises from 0% among non-farmers to 11-12% among farmers with more than two hectares. The role of maize in expenditure is relatively constant across farm-size categories, though lower in the non-farm households, many of which are located in urban areas and thus have higher incomes. The net effect is that non-farms and small farms are adversely affected by higher maize prices, while farms with more than two hectares are positively affected by higher maize prices.

We now turn to the impact of the increase in maize price on poverty in Ghana. Between June 2007 and June 2008, the nominal consumer price of maize in Accra rose 81%. If we assume a marketing margin that is a fixed share of the consumer price, then producer prices would have also increased 81%. If we assume that the marketing margin is fixed and that producer prices are half of consumer prices, then the producer price would have increased 162%. Table 18 shows the effect of higher maize prices on poverty in Ghana under different assumptions about the household response and about the margin between producer and consumer prices.

At the national level, an 81% increase in both consumer and producer prices of maize increases poverty 0.6 percentage points in the short-run, that is from 24.4% to 25.0%. If we assume a fixed marketing margin so that producer prices rise more than consumer prices, the higher maize price actually reduces poverty by 1.2 percentage points. This is because the producer price increases (and hence the gains to producers) are twice as large. In the long run, the effect s are more positive or less negative as households adapt to the price increases. For example, if producer prices rise more than consumer prices, poverty rate falls 2.1 percentage points in the long run.

Urban household lose in both the short- and long-run from higher maize prices, but the average losses are smaller in the long run. Rural households lose in the base simulation (no household response, equal percentage increase in producer and consumer prices), but gain in the long run and if producer prices rise more than consumer prices (see Table 18).

As mentioned above, female-headed households are more vulnerable to increases in maize prices. Poverty among female-headed households rises in three of the four simulations, while poverty among male-headed households falls in three of the four simulations. As noted above, female-headed households are less likely to grow and sell maize than male-headed households. However, it should be noted that female-headed households have a lower poverty rate (18%) than male-headed households (36%).

Not surprisingly, maize farmers gain from higher prices under all four alternative assumptions, with the decline in poverty ranging from 0.3 percentage points to 6.0 percentage points. In contrast, the poverty rate rises 0.9 to 1.3 percentage points among other households, depending on the assumptions. It is worth noting that maize farmers are poorer than other households, but the poverty rate (36%) is similar to that of rural households in general (35%) (see Table 18).

The poverty impact is quite varied across regions. In the base simulation (short term, equal percentage increase in consumer and producer prices), the poverty rate increases more than 3 percentage points in Volta and the Upper East region, both of which have highly negative net benefit ratios. On the other hand, the higher prices cause poverty to decline slightly (less than 1 percentage point) in the Ashanti, Central, and Northern regions. Overall, poverty increases in seven of the ten regions. If we assume a fixed marketing margin, however, then poverty declines in most of the regions. In simulation 4 (long term, producer prices rising more than consumer prices), poverty declines a full 8 percentage points in the Northern region, one of the poorest regions. On the other hand, higher maize prices increase poverty in the Upper East, an even poorer region.

Looking at the impact by expenditure quintile, we know from Table 17 that the poor are net buyers of maize, so it is not surprising that the second and third quintiles experience higher poverty in the base simulation. Since the poverty rate in the poorest quintile is already 100%, it cannot increase any further, but a few net sellers escape poverty with the higher maize prices. In fact, if producer prices rise more than consumer prices and household are able to respond to the higher prices (simulation 4), 6% of the poorest quintile escape poverty. The higher prices have no effect on the poverty rate among the top two quintiles because they are too far above the poverty line (see Table 18).

Finally, we examine the impact on households grouped by farm size. It is interesting to note that the poverty rate is higher among farmers with more than 2 hectares compared to those with less than 2 hectares. Presumably, the former are concentrated in the north and other areas where the agricultural potential is low. The poverty rate among non-farmers, being net buyers, rises in all simulations, but because their initial poverty rate is low (9%), few households are pushed into poverty. Across all simulations, small farmers lose more (or gain less) than large farmers because they are more likely to be net buyers of maize. In the base simulation, farmers with less than 2 hectares lose, while those with more than 2 hectares gain from the higher maize prices. If producer prices rise more than consumer prices, all farm categories gain, but large farmers more so. In simulation 4, the poverty rate among farmers with more than 2 hectares falls by around 7 percentage points.

Table 17. Net position in maize of different types of households in Ghana

Category of household	Pct of all households (percent)	Production ratio	Consumption ratio	Net benefit ratio	Net sellers	Self sufficient	Net buyers
		(fraction of income)			(% of households in category)		
Urban	43	0.01	0.03	-0.02	7	37	56
Rural	57	0.07	0.09	-0.01	31	31	39
Male headed	71	0.06	0.07	-0.01	24	33	43
Female headed	29	0.02	0.05	-0.03	13	33	54
Maize grower	41	0.12	0.10	0.02	51	20	29
Other households	59	0.00	0.03	-0.03	0	42	58
Western	10	0.02	0.02	-0.01	16	37	47
Central	10	0.04	0.04	0.00	28	41	31
Greater Accra	17	0.01	0.02	-0.01	4	38	58
Volta	8	0.09	0.15	-0.06	20	15	65
Eastern	14	0.05	0.06	-0.02	23	26	51
Ashanti	17	0.03	0.02	0.01	25	35	40
Brong Ahafo	9	0.05	0.05	0.00	31	36	34
Northern	9	0.15	0.17	-0.02	33	31	36
Upper East	4	0.04	0.13	-0.09	9	33	57
Upper West	2	0.12	0.20	-0.09	12	36	52
Poorest quintile	20	0.09	0.12	-0.03	27	35	38
2nd quintile	20	0.06	0.08	-0.02	28	29	44
3rd quintile	20	0.04	0.05	-0.01	21	29	49
4th quintile	20	0.03	0.04	-0.01	16	33	51
Richest quintile	20	0.02	0.02	-0.01	10	41	50
No farm	41	0.00	0.03	-0.03	2	40	59
0.01 - 0.5 ha	19	0.05	0.07	-0.02	27	30	44
0.5 - 2.0 ha	17	0.07	0.09	-0.02	33	27	40
2 - 5 ha	15	0.12	0.10	0.01	40	29	31
More than 5 ha	8	0.11	0.09	0.02	41	31	28
Average	100	0.05	0.06	-0.01	21	33	46

Source: Analysis of the 2005-06 GLSS data.

Table 18. Impact on poverty in Ghana of maize price increases of 2007-08

		Short-term change in poverty rate		Long-term change in poverty rate	
	Initial poverty rate (percent)	81% increase in producer and retail maize price (pct point change)	81% increase in retail price, 162% increase in producer price (pct point change)	81% increase in producer and retail maize price (pct point change)	81% increase in retail price, 162% increase in producer price (pct point change)
Urban	10%	0.5	0.1	0.3	0.0
Rural	35%	0.7	-2.2	-0.2	-3.6
Male headed	27%	0.3	-1.9	-0.4	-2.9
Female headed	18%	1.3	0.5	0.9	0.0
Maize farmers	36%	-0.3	-4.3	-1.5	-6.0
Others	16%	1.3	1.1	1.2	0.9
Western	17%	1.0	0.0	0.5	-0.4
Central	17%	-0.3	-1.9	-0.6	-2.2
Greater Accra	7%	0.5	0.5	0.4	0.3
Volta	31%	3.6	0.4	2.0	-2.2
Eastern	15%	0.8	-1.1	0.4	-1.8
Ashanti	19%	-0.6	-1.8	-1.0	-2.4
Brong Ahafo	29%	0.3	-1.6	-0.1	-2.8
Northern	54%	-0.4	-6.4	-2.0	-8.4
Upper East	73%	3.1	1.9	3.1	1.3
Upper West	89%	1.9	-1.0	1.1	-1.7
Poorest quintile	100%	-0.9	-3.9	-1.3	-6.4
2nd quintile	24%	3.6	-2.4	1.3	-4.1
3rd quintile	0%	0.2	0.2	0.1	0.1
4th quintile	0%	0.0	0.0	0.0	0.0
Richest quintile	0%	0.0	0.0	0.0	0.0
No farm	9%	0.9	0.8	0.9	0.7
0.01-0.5 ha	26%	1.4	-0.3	0.7	-1.4
0.5 - 2.0 ha	38%	0.7	-1.8	0.1	-2.8
2.0 - 5.0 ha	41%	-0.8	-5.1	-1.8	-7.4
Over 5 ha	41%	-0.7	-5.4	-2.6	-6.6
Ghana	24%	0.6	-1.2	0.0	-2.1

Source: Analysis based on 2005-06 GLSS.

Note: Short-term impact assumes no response to new prices by households. Long-term impact assumes response.

Welfare impact of higher rice prices in Ghana

The net position in rice for different types of households in Ghana is shown in Table 19. In contrast to maize, which is grown by many households (41%) throughout Ghana as a subsistence crop, rice is grown by a relatively small number of households (5%) concentrated in the north, many of whom grow it as a commercial crop. Among rice farmers, rice accounts for 11% of income but rice consumption is just 6% of the total. Furthermore, 61% of rice farmers are net sellers, compared to just 51% for maize.

For both urban and rural households, rice consumption is equivalent to about 3% of income, so the urban NBR is -0.03 and the rural NBR is -0.02. Although rice is less important than maize both in terms of income and in terms of consumption, an increase in rice prices has a more negative impact on households than a similar increase in maize prices because the average "deficit" in rice is larger. Just 4% of rural households and 1% of urban households are net sellers and thus would benefit from higher rice prices.

The regional breakdown shows that rice production is concentrated in the three northern regions: Northern, Upper West, and Upper East. In these three regions, net rice sellers represent 10-20% of the households, compared to 0-3% in the other regions. The share of income from rice is also higher in these three regions, 2-4% compared to 0-1% in the other regions. Nonetheless, even in these three regions, the NBR is slightly negative (-0.01), suggesting that the negative effect of higher rice prices on consumers in these regions slightly outweighs the positive effect on rice growers. The NBR is more negative in the other regions of the country, ranging from -0.02 to -0.04 (see Table 19).

Commercial rice farmers are mostly found in the poorest income categories. Among the poorest quintil of households in Ghana, net sellers of rice are 9% of the total, compared to 1-3% in other quintiles. Nonetheless, because most of the households in the poorest quintile (60%) are net buyers, the NBR in rice for this group is negative, implying that they lose from higher rice prices, on average. The NBR does not seem to vary in a consistent way across income categories, which indicates that all income groups are hurt to roughly the same degree by higher rice prices.

Finally, the proportion of households that are net rice sellers rises with farm size. Net sellers are rare among non-farm households (1%) and households with farms with less than 0.5 hectares (2%), but relatively more common those with 2-5 hectares (5%) and those with more than 5 hectares (8%). Nonetheless, because all farm-size categories have a majority of net rice buyers, the NBR is negative (-0.02 to -0.03) for all categories. Net rice sellers are more common among the poorest households and among those with the largest farms, a reflection of the fact that the poverty rate is higher among farmers with more than 2 hectares compared to those with less (see Table 19).

The impact of higher rice prices on the poverty rate among different types of households in Ghana is shown in Table 20. The retail price of rice in Accra increased almost 36% between June 2007 and June 2008. In the first and third simulations, it is assumed that both producer and consumer rice prices rise 36%. In the second and fourth, we assume that the producer rice price rises twice as much as the consumer rice price (71%).

We can draw two general conclusions from these results. First, almost all household types experience higher poverty rates as a result of the higher rice prices, regardless of the assumptions used. Urban, rural, male- and female-headed, households in all ten regions, and those in all five expenditure categories. The only groups for which a higher rice price means a lower poverty rate are rice farmers and farmers with more than five hectares of land. The poverty rate among rice farmers, which starts at a very high 70%, declines between 1.4 and 2.5 percentage points, depending on the assumptions adopted.

The second conclusion is that the impact of rice price increases on poverty are relatively small. Only in two cases does the poverty rate rise more than one percentage point: in the Western region and in the second quintile. The Western region has the most negative net benefit ratio for rice, a result of high rice consumption and the negligible rice production in this region. The effect on the poverty rate for the second quintile is simply due to the fact that it has a large number of households near the poverty line.

Table 19. Net position in rice of different types of households in Ghana

Category of household	Pct of all households	Produc-tion ratio	Consump-tion ratio	Net benefit ratio	Net sellers	Self sufficient	Net buyers
	(percent)	(fraction of income)			(% of households in category)		
Urban	43	0.00	0.03	-0.03	1	19	80
Rural	57	0.01	0.03	-0.02	4	20	75
Male headed	71	0.01	0.03	-0.02	4	22	74
Female headed	29	0.00	0.03	-0.03	1	15	84
Rice grower	5	0.11	0.06	0.05	61	15	24
Other households	95	0.00	0.03	-0.03	0	20	80
Western	10	0.00	0.04	-0.04	1	10	89
Central	10	0.00	0.03	-0.03	0	13	87
Greater Accra	17	0.00	0.02	-0.02	2	23	75
Volta	8	0.00	0.03	-0.02	1	19	80
Eastern	14	0.00	0.03	-0.03	1	18	81
Ashanti	17	0.00	0.03	-0.03	1	16	82
Brong Ahafo	9	0.01	0.03	-0.02	3	21	76
Northern	9	0.02	0.03	-0.01	10	31	59
Upper East	4	0.04	0.05	-0.01	20	24	55
Upper West	2	0.02	0.03	-0.01	10	57	34
Poorest quintile	20	0.01	0.03	-0.02	9	31	60
2nd quintile	20	0.01	0.03	-0.03	3	17	80
3rd quintile	20	0.00	0.03	-0.03	2	16	82
4th quintile	20	0.00	0.03	-0.03	1	16	83
Richest quintile	20	0.00	0.03	-0.02	1	19	81
No farm	41	0.00	0.03	-0.03	1	21	78
0.01 - 0.5 ha	19	0.00	0.03	-0.03	2	14	84
0.5 - 2.0 ha	17	0.01	0.03	-0.02	4	20	77
2 - 5 ha	15	0.01	0.03	-0.02	5	22	73
More than 5 ha	8	0.01	0.03	-0.02	8	24	67
Average	100	0	0.03	-0.02	3	20	77

Source: Analysis of the 2005-06 GLSS data.

Table 20. Impact on poverty in Ghana of rice price increases of 2007-08

		Short-term change in poverty rate		Long-term change in poverty rate	
	Initial poverty rate (percent)	36% increase in producer and retail rice price (pct point change)	36% increase in retail price, 71% increase in producer price (pct point change)	36% increase in producer and retail rice price (pct point change)	36% increase in retail price, 71% increase in producer price (pct point change)
Urban	10%	0.3	0.3	0.3	0.3
Rural	35%	0.5	0.4	0.5	0.4
Male headed	27%	0.4	0.4	0.4	0.3
Female headed	18%	0.5	0.5	0.5	0.5
Rice farmers	70%	-1.4	-2.3	-1.5	-2.4
Others	22%	0.5	0.5	0.5	0.5
Western	17%	1.2	1.2	1.2	1.2
Central	17%	0.6	0.6	0.6	0.6
Greater Accra	7%	0.0	0.0	0.0	0.0
Volta	31%	0.2	0.2	0.2	0.2
Eastern	15%	0.2	0.2	0.2	0.2
Ashanti	19%	0.6	0.6	0.6	0.6
Brong Ahafo	29%	0.6	0.5	0.5	0.3
Northern	54%	0.3	0.1	0.3	0.1
Upper East	73%	0.2	0.0	0.2	0.0
Upper West	89%	0.6	0.6	0.6	0.6
Poorest	100%	0.0	0.0	0.0	0.0
2nd quintile	24%	2.2	2.0	2.1	1.9
3rd quintile	0%	0.0	0.0	0.0	0.0
4th quintile	0%	0.0	0.0	0.0	0.0
Richest	0%	0.0	0.0	0.0	0.0
No farm	9%	0.2	0.2	0.2	0.2
0.01-0.5 ha	26%	0.9	0.9	0.8	0.8
0.5 - 2.0 ha	38%	0.6	0.6	0.6	0.6
2.0 - 5.0 ha	41%	0.6	0.4	0.6	0.3
Over 5 ha	41%	-0.2	-0.2	-0.2	-0.2
Ghana	24%	0.4	0.4	0.4	0.4

Source: Analysis based on 2005-06 GLSS.

Note: Short-term impact assumes no response to new prices by households. Long-term impact assumes response.

Welfare impact of higher food prices in Ghana

The net position in food for different types of households in Ghana is shown in Table 21. About 21% of the households in Ghana are net food sellers, while 79% are net buyers. The net buyers pay for their purchases with the sale of cocoa and other non-food crops, wage income, and non-farm self-employment, among others. On average, food accounts for 36% of household income and food consumption represents 49% of the total. Thus, the average NBR is -0.13. This implies that a 10% increase in consumer and producer prices of food would reduce real income by 1.3% in the short run.

The impact of higher food prices is more adverse in urban areas, where the food NBR of -0.27 means that a 10% increase in food prices results in a 2.7% reduction in real income in the short run. In rural areas, the food NBR is slightly negative (-0.03), implying a small but negative impact of higher food prices. Even in rural areas, two-thirds of households are net buyers of food.

Female-headed households are much more adversely affected by higher food prices than male-headed households. Although the food share in the budget is similar for the two groups (about half), food production is a smaller share of income for female-headed households than for male-headed households (see Table 21).

A majority (59%) of Ghanaian households grow food, and food production accounts for 62% of their income, but food consumption absorbs most of that, so that net sales are just 7% of income.

Furthermore, among food growers, barely one-third of them are net sellers of food. For households that do not grow food (including most urban households), food consumption represents 41% of the budget, implying a large negative NBR.

In terms of the regional impact, higher food prices have the most negative impact on Greater Accra, where 97% are net buyers of food and a 10% increase in food prices would result in a short-term loss of 3.7% in purchasing power. The adverse impact would also be large in Volta and the Eastern region, among others. The only regions that would benefit from higher food prices in the short-term are Upper West, Brong Ahafo, and the Northern region. These regions have a relatively high proportion of net sellers of food (28-39%), whose gains would outweigh the losses of the net buyers in those regions (see Table 21).

Looking at the results by income category, the poorest households gain slightly from higher food prices in the short run, while the highest-income households lose significantly. Although barely one third of the poorest quintile are net sellers of food, their gains outweigh the losses of the net buyers so that the food NBR for the poorest quintile is positive (0.06), indicating a positive short-term impact from higher prices. As we move to the higher-income quintiles, the NBR turns increasingly negative and the proportion of net sellers of food rise. For the highest-income quintile, the average NBR is -0.29, implying that a 10% increase in food prices reduces the real income of this income group by 2.9%.

Finally, there is a strong relationship between farm size and the impact of higher food prices. The proportion of net sellers of food rises from 2% among the non-farmers to 23% among the smallest farmers to 63% among those with more than 5 hectares. Similarly, the NBR is -0.41 for non-farmers, but rises to 0.43 among those with farms of more than 5 hectares. It should be noted that 41% of the households in Ghana have no farm (mostly urban households), while only 8% have more than 5 hectares (see Table 21).

The impact of higher food prices on the poverty rate for different types of households in Ghana is shown in Table 22. Between June 2007 and June 2008, the food consumer price index in Ghana increased by 18%. The first and third simulations assume that the producer prices of food increased in the same proportion. In contrast, the second and fourth simulations assume that producer prices rose twice as much as consumer prices (36%), based on the assumption of a marketing margin fixed in absolute terms and the assumption that producer prices are half of consumer prices. As above, the first two simulations give the short run impact, before households can respond to the higher prices, while the second pair give the long run impact, assuming that households respond both as consumers and as producers.

In the short run, an 18% increase in both producer and consumer food prices increases the national poverty 0.9 percentage points, that is from 24.4% to 25.3%. Although the long run impact on poverty is roughly similar, the results are quite different if we assume that consumer food prices rise 18% and producer food prices increase 36%. In this case, the national poverty rate actually declines by about 2 percentage points.

The results differ between urban and rural households. In urban areas, higher food prices increase poverty by 0.6 to 1.1 percentage points across all four simulations. In rural areas, higher food price increases raise poverty slightly if we assume producer and consumer prices rise proportionally. However, if we assume producer prices rise more than consumer prices, the rural poverty declines about 4 percentage points, that is, from 35% to 31% (see Table 22).

The simulations indicate that female-headed households are more vulnerable than male-headed households to increases in food prices. In the short run with proportional increases in all food prices, the poverty rate among female-headed households rises 2.1 percentage points, compared to just 0.3 percentage points among male-headed households. In the other simulations, the outcome is more positive for both, but male-headed households gain more (or lose less) than female-headed households. As noted above, however, female-headed households have a lower poverty rate (18%) than male-headed households (36%).

Food producers include most of the rural households and even some urban households. If producer and consumer prices both rise by 18%, the effect is close to zero because these households grow and consume similar quantities. If producer prices rise more than consumer prices, however, then the poverty rate falls by more than 4 percentage points, that is, from 35% to 30-31%. Household that don't produce food lose in all four simulations, with poverty rising close to 2 percentage points (see Table 22).

The regions that are least negative affected by higher food prices are the Northern region, Brong Ahafo, and Upper West. These are the only regions with a positive net benefit ratio for food (see Table 21) and where poverty declines in the base simulation. Volta, Eastern, and Western regions are the most adversely affected by the higher food prices. If producer prices rise more than consumer prices, the differences across regions are similar, but the overall impact is more positive. In this case, poverty declines in 9 of the 10 regions, the exception being Greater Accra. The positive impact is particularly notable in the Northern region, where poverty declines by 7 percentage points.

The impact of higher food prices varies widely across expenditure quintiles. The poorest quintile consists of 100% poor households, so the rate cannot increase. Some net sellers from this group gain from higher prices, so the poverty rate declines 2-7 percentage points. The second quintile contains a large number of households near the poverty line. If the producer and consumer food prices both increase by 18%, the poverty rate increases by 5-6 percentage points because these households are net buyers of food. If the producer prices of food rise more than consumer prices, the poverty rate in this quintile declines by 2-3 percentage points. Higher food prices have no effect on the poverty rate among the households in the third, fourth, and fifth quintiles; any adverse effects on net buying households is not enough to push them below the poverty line (see Table 22).

Examining the impact by farm-size category, non-farmers lose from higher prices in all simulations. The poverty rate increases about 1.7 percentage points in three of the four simulations, implying an increase in poverty from 9.0% to 10.7%. Among farmers, only those with more than 2 hectares gain if producer and consumer prices rise by the same proportion. If producer prices rise more than consumer prices, all farmer categories experience a reduction in poverty, though the effect is largest for the larger farmers.

Table 21. Net position in food of different types of households in Ghana

Category of household	Pct of all households	Produc-tion ratio	Consump-tion ratio	Net benefit ratio	Net sellers	Self sufficient	Net buyers
	(percent)	(fraction of income)			(% of households in category)		
Urban	43	0.15	0.42	-0.27	7	0	93
Rural	57	0.53	0.55	-0.03	31	0	68
Male headed	71	0.42	0.50	-0.07	25	0	75
Female headed	29	0.22	0.49	-0.27	12	0	88
Food grower	59	0.62	0.55	0.07	34	0	66
Other households	41	0.00	0.41	-0.41	1	1	98
Western	10	0.38	0.50	-0.12	24	0	75
Central	10	0.36	0.51	-0.15	23	0	77
Greater Accra	17	0.02	0.39	-0.37	3	1	97
Volta	8	0.34	0.54	-0.20	20	0	79
Eastern	14	0.33	0.54	-0.21	20	0	80
Ashanti	17	0.23	0.41	-0.19	18	0	81
Brong Ahafo	9	0.78	0.54	0.24	38	0	62
Northern	9	0.72	0.60	0.13	39	0	60
Upper East	4	0.51	0.61	-0.10	16	0	84
Upper West	2	0.87	0.61	0.25	28	0	71
Poorest quintile	20	0.61	0.55	0.06	36	0	63
2nd quintile	20	0.50	0.52	-0.03	26	0	74
3rd quintile	20	0.35	0.50	-0.15	20	0	80
4th quintile	20	0.23	0.47	-0.24	14	0	86
Richest quintile	20	0.14	0.43	-0.29	9	0	91
No farm	41	0.01	0.42	-0.41	2	1	98
0.01 - 0.5 ha	19	0.40	0.54	-0.14	23	0	77
0.5 - 2.0 ha	17	0.50	0.55	-0.05	26	0	73
2 - 5 ha	15	0.82	0.56	0.26	44	0	56
More than 5 ha	8	0.98	0.55	0.43	63	0	37
Average	100	0.36	0.49	-0.13	21	0	79

Source: Analysis of the 2005-06 GLSS data.

Table 22. Impact on poverty in Ghana of food price increases of 2007-08

		Short-term change in poverty rate		Long-term change in poverty rate	
	Initial poverty rate (percent)	18% increase in producer and retail food prices (pct point change)	18% increase in retail prices, 36% increase in producer prices (pct point change)	18% increase in producer and retail food prices (pct point change)	18% increase in retail prices 36% increase in producer prices (pct point change)
Urban	10%	1.1	0.6	1.0	0.5
Rural	35%	0.7	-3.6	0.3	-4.0
Male	27%	0.3	-2.7	0.1	-3.0
Female	18%	2.1	0.3	1.8	0.0
Food producer	35%	0.2	-4.3	-0.2	-4.7
Others	9%	1.8	1.8	1.7	1.7
Western	17%	1.4	-1.8	0.9	-2.2
Central	17%	0.8	-1.8	0.2	-2.2
Greater Accra	7%	1.1	0.6	1.1	0.6
Volta	31%	2.1	-1.5	1.7	-2.1
Eastern	15%	1.6	-0.1	1.6	-0.5
Ashanti	19%	1.2	-1.1	1.0	-1.4
Brong Ahafo	29%	-0.5	-5.1	-1.3	-5.5
Northern	54%	-1.5	-7.0	-1.8	-7.1
Upper East	73%	1.2	-1.3	1.2	-1.6
Upper West	89%	-0.5	-4.1	-0.7	-4.4
Poorest	100%	-2.1	-6.7	-2.4	-7.2
2nd quintile	24%	6.4	-2.3	5.3	-3.4
3rd quintile	0%	0.0	0.0	0.0	0.0
4th quintile	0%	0.0	0.0	0.0	0.0
Richest	0%	0.0	0.0	0.0	0.0
No farm	9%	1.7	1.7	1.7	1.6
0.01-0.5 ha	26%	1.9	-1.2	1.4	-1.9
0.5 - 2.0 ha	38%	1.1	-2.8	0.8	-3.3
2.0 - 5.0 ha	41%	-0.6	-6.6	-1.2	-6.8
Over 5 ha	41%	-4.2	-10.5	-4.3	-10.7
Ghana	24%	0.9	-1.8	0.6	-2.1

Source: Analysis based on 2005-06 GLSS.

Note: Short-term impact assumes no response to new prices by households. Long-term impact assumes response.

5. Summary and conclusions

As described above, the results of this study can be divided into three parts. The first part is an examination of the trends in staple food prices in sub-Saharan Africa over 2007-08. The second is an econometric analysis of price transmission from international markets to domestic markets in Africa. And the third part uses household survey data to analyze the distributional impact of food price increases in Ghana and Kenya. The results are summarized below, along with a discussion of implications for future research.

5.1. Staple food price trends in sub-Saharan Africa

Staple food prices in sub-Saharan Africa have risen rapidly since 2006, even in US dollar terms. Across 83 food prices in eleven countries examined in this report, the average increase between June 2007 and June 2008 was 63% in US dollar terms. On average, this represents 71% 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%) in South Africa, Ghana, and Cameroon. On the other hand, food prices increases were quite large (over 150%) in Ethiopia and Malawi. Since the price increases in these latter two countries actually exceed the price increase in the world markets for the same commodities, this suggests that domestic factors (such as inflation, crop failure, or manipulation of the exchange rate) must have played an important role in the price hike. The price increases in domestic African markets also varied by commodity. The price increases in African markets were highest for maize (87%), followed by wheat (65%), and rice (62%). Other commodities experienced smaller increases, particularly plantains (9%) and cassava (12%). The degree of price increase appears to be related to the degree of tradability: highly tradable commodities are more closely linked to international markets and so domestic prices of these commodities tracked the spike in world prices. Commodities that are less widely traded in international markets saw smaller increases in prices 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 consist of 62 domestic price series for maize, rice, and wheat in nine sub-Saharan African countries. Each domestic price series is tested against the world price of the same commodity.

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

Although less than a third 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 have the highest proportion of prices that are linked to world markets, though the share is less than 40% in all three cases. Zambia, Uganda, and Kenya have no prices that show a long-run relationship with world markets.

The differences across commodities are somewhat clearer. Just 10% of the domestic maize prices tested are significantly related to world maize prices, but almost half of the domestic rice prices are related to world rice prices. This implies that rice markets in Africa are generally better connected to world markets than maize markets. This result in 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% of the domestic consumption in eight of the nine countries under consideration; the exception is Mozambique, where maize imports are equivalent to 14% of domestic production. Among the three countries whose rice prices were tested, rice imports represent more than 50% of domestic consumption in Ghana and Mozambique and 11% 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 2008-09, and the econometric analysis, which suggests that often there is 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 4-8 years. It is possible that policy reforms in recent years have made African markets have more responsive to conditions 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 2007-08 than in 2003-2007.

Second, unlike normal fluctuation in world food prices, the food crisis coincided with a sharp increase in oil prices, which rose from US$ 71 per barrel in June 2007 to US$ 133 per barrel a year later (see Figure 1). This led to much higher costs of fertilizer, sea-freight, and overland transportation, which would raise the cost of domestically produced and imported food. Since fuel costs represent less than half of transportation cost, and transportation costs generally account for up to half of imported food cost, an 87% increase in fuel prices could account for a 20-25% increase in imported grain costs. Thus, higher fuel costs may be an important contributing factor, but it is not be 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 global food crisis, Malawi, Zambia, and Tanzania all banned the export of maize, while several West 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, the higher food and oil prices may have started an inflationary process in some countries, an occurrence that normal fluctuations in food prices does not cause. With market-determined exchange rates, the depreciation would largely offset the inflation, leaving prices as we measured them (in US dollar terms) relatively unchanged. However, domestic inflation combined restrictions on the foreign currency market would drive up domestic African prices, in US$ dollar terms. This could be part of the explanation in some countries, such as Malawi and Ethiopia, where domestic food price increases actually exceeded world food price increases. But in most countries, the increase in food prices was much greater than the increase in the general price level, as measured by the consumer price indices.

Fifth, there may 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 of the African grain prices do show significant spikes that are not related to world prices and are presumably driven by poor harvests. However, when the shock from international markets is large, as it was in 2007-08, the price changes are transmitted to local markets or at least the transmission to local markets becomes measurable with econometric methods.

In summary, we hypothesize that international prices of food grains do have an 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 2007-08 was more clearly transmitted, partly because it was a large shock, partly because it was accompanied by sharply higher transportation costs, and partly because many African countries attempted to ban grain exports in response to the emerging crisis, thus exacerbating food price increases in landlocked countries.

5.3. Distributional effect of higher food prices in Ghana

We use household survey data from Ghana to examine the distributional effects of higher prices of maize, rice, and food in general. On average, maize accounts for 6% of expenditure and 5% of income in Ghana, so the net benefit ratio is slightly negative. This implies that the short-run effect of increases in maize prices is slightly negative for households in Ghana. The simulations indicate that an 81% increase in producer and consumer maize prices raises the poverty rate by 0.6 percentage points. This relatively small impact reflects the fact that the decrease in poverty among surplus maize farmers is roughly equal to the increase in poverty among net buyers of maize. The adverse effect on income and poverty is greatest for households in the Upper East, Upper West, and Volta regions, urban households, female-headed households, poor households, and those with small farms. Among these groups, the poverty rate rises 0.1 to 3.6 percentage points in the base simulation. On the other hand, maize farmers, farmers with more than 2 hectares of land, and those in three regions actually benefit from higher maize prices. The results of the short- and long-run simulations were fairly similar, though the latter were somewhat more positive because they take into account household responses to the higher prices. On the other hand, the results were quite sensitive to the assumption about the marketing margin. If we assume a fixed marketing margin, producer prices rise more than consumer prices, and the impact of higher prices is significantly more positive.

In Ghana, rice is less important than maize in several ways. Rice accounts for 3% of consumption, compared to 6% for maize. The value of rice production is less than 1% of household income, compared to 5% for rice. Rice is grown by just 5% of Ghanaian households, compared to 41% who grow maize. In spite of this, the adverse impact of a given price increase is greater for rice than for maize because the net benefit ratio is more negative. This is a reflection of the fact that Ghana is essentially self-sufficient in maize but has a net deficit in rice, so the aggregate gains to rice farmers from higher rice prices are significantly less than costs to rice consumers. Higher rice prices have a strong distributional effect as well, since rice farmers are quite poor (70% are poor, compared 35% of all rural households) and rice consumers are disproportionately high-income urban households. Retail prices of rice rose 36% over 2007-08. Simulations of the rice price increase confirm that rice farmers benefit, but almost every other group (defined by location, sex of head, region, expenditure quintile, or farm-size category) is negatively affected by higher rice prices. The effect is relatively small, however. The higher rice price raises the national poverty rate by 0.4 percentage points; for almost all groups, the increase in poverty is less than 1 percentage point. For the same percentage increase, a rice price would have a more adverse effect than a maize price increase, but the rice price increase over 2007-08 was smaller (36%) than the maize price increase (81%) over that period.

Food production represents 36% of household income, while food consumption accounts for 49% of household expenditure. This means that the net benefit ratio is -0.13, implying that increases in producer and consumer prices would adversely affect household income in the short run. The adverse effect is greatest for urban households, female-headed households, households in Greater Accra, richer households, and those with small farms. A few groups would gain from higher food price: food growers, households in Brong Ahafo, Northern, and Upper West regions; and households with more than 2 hectares of land. The increase in the food consumer price index over 2007-2008 was 18%. If producer price increase rose in the same proportion, national poverty would increase about 1 percentage point. However, if producer prices rose more than consumer prices, the national poverty rate would decline by 2 percentage points.

5.4. Policy implications of the findings

The global food crisis of 2007-08 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: 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 90-95% 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[11].

Another approach, probably more appealing in the short term, is to restrict imports through tariffs, quotas, or a full-scale import ban. If enforceable, these policies would increase the rate of "self-sufficiency" quickly at no cost to the government, but it 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 must be still higher. This means that avoiding vulnerability to a spike in world grain prices like the one in 2007-08 could 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 food security, particularly among 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 or larger than volatility due to international markets:

- The price of maize in South African commodity markets is more stable than the price of maize in most other sub-Saharan African countries. The coefficient of variation[12] (CV) of maize prices on the South African commodity exchange is about 0.26, compared to an average of 0.39 for 34 markets in eight African countries for which data were available.
- The import parity price of maize in sub-Saharan Africa is more stable than the domestic price of maize in most sub-Saharan African countries. The CV of the US yellow maize price is 0.33, but the import parity price of US maize in Africa is just 0.18. This is based on a conservative (low) assumption of US$ 100/ton cost of delivery. If the delivery cost is higher, the CV of the import parity price would be even lower.

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

[12] The coefficient of variation (CV) is a measure of volatility, defined as the standard deviation divided by the mean.

- In markets of sub-Saharan Africa, the price of rice (a largely tradable grain) is more stable than the price of maize (a largely non-tradable grain). The average CV of rice prices in 13 African markets is 0.22, compared to the average CV of maize prices in 34 African markets of 0.39.

As discussed above, the global food crisis was exacerbated when several major exporters restricted grain exports in response to the rising prices[13]. 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 limit food export restrictions as part of multi-lateral trade agreements.

Similarly, the effects of another spike in world food prices could be ameliorated if African countries themselves restrained 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, the implication is that 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 allow 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 order 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 non-tradable 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 to develop and disseminate methods for processing root crops and non-tradable grains to increase shelf-life and make food preparation easier.

5.5. Future directions in 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.

[13] This was the case for Argentina, Russia, and the Ukraine in wheat and India and Vietnam in rice.

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 and/or justifiably high costs of moving commodities between distant locations. A threshold auto-regressive model distinguishes between situations when the price difference is large, justifying trade between the markets and co-movement of prices, and when price differences are small, during which no co-movement is expected (see van Campenhout, 2007 and Meyers, 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 premia.

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 2007-08. Several hypotheses to explain this were proposed in section 5.2. Further research would help to narrow the list of possible explanations.

Third, the analysis of the distributional impact should be replicated in other countries, particularly in sub-Saharan Africa. One of the constraints on this type of analysis is the availability of household surveys that measure both disaggregated food expenditure and disaggregated income, including crop-level income. Such surveys are expensive, but the data are necessary for understanding the distribution impact of rising food prices, food trade policy, and other types of food policy.

Fourth, the analysis of the welfare impact revealed that the results are not very sensitive to the supply and demand elasticities used (at least within the plausible range of 0.0 to 0.3). On the other hand, the results are quite sensitive to assumptions regarding the marketing margin, confirming the finding of Dawe and Matsoglou (2009). To improve estimates of the welfare impact of changing food prices, it is important to better understand the effect of food price changes on the marketing margin between producer prices and consumer prices. If the standard assumption that both prices change in the same percentage is wrong, the welfare impact of higher prices may be biased toward adverse impact.

References

Abdulai, A. 2000. "Spatial price transmission and asymmetry in the Ghanaian maize market." *Journal of Development Economics* 63: 327–349.

Alston, J., C. Chan-Kang, M. Marra, P. Pardey, and T.J. Wyatt. 2000. *A Meta-Analysis of Rates of Return to Agricultural R&D: Ex Pede Herculem?* Research Report No 113. International Food Policy Research Institute. Washington, D.C.

Arndt, C., R. Benefica, N. Maximiana, A. Nucifora, and J. Thurlow. 2008. "Higher fuel and food prices: impacts and responses for Mozambique" *Agricultural Economics* 39 supplement 497–511.

Babcock, B. 2008. "Statement before the U.S. Senate Committee on Homeland Security and Government Affairs." Hearing on Fuel Subsidies and Impact on Food Prices, May 7, 2008.

Balke, N. and T. Fomby. 1997. "Threshold cointegration." *International Economic Review* 38: 627–645.

Banda, 2008. "Zambia too suspends maize exports." *Africa News.* 8 May 2008. http://www.africanews.com/site/list_messages/18092.

Barrett, C. and J.R. Li. 2002. "Distinguishing between equilibrium and integration in spatial price analysis." *American Journal of Agricultural Economics* 84 (2): 292-307.

Barrett, C. B., and P. A. Dorosh. 1996. "Farmers' welfare and changing food prices: Nonparametric evidence from rice in Madagascar." *American Journal of Agricultural Economics* 78 (August): 656–669.

Baulch, B. 1997. "Testing for food market integration revisited." *Journal of Development Studies*, 33: 477-487.

Budd, J. W. 1993. "Changing food prices and rural welfare: A nonparametric examination of the Côte d'Ivoire." *Economic Development and Cultural Change* 41 (April): 587–603.

Cudjoe, G., C. Breisinger, and X. Diao. 2008. "Local impacts of a global crisis: food price transmission and poverty impacts in Ghana." IFPRI Discussion Paper 00842. International Food Policy Research Institute. Washington, DC.

Dawe, D. and I. Maltsoglou. 2009. "Analyzing the Impact of Food Price Increases: Assumptions about Marketing Margins can be Crucial**."** ESA Working Paper No. 09-02. Food and Agriculture Organization, Rome.

Deaton, A. 1989. "Rice prices and income distribution in Thailand: A non-parametric analysis." *Economic Journal* 99 (395) (Supplement): 1–37.

Engle, R. and C. Granger. 1987. "Co-integration and error-correction: Representation, estimation, and testing." *Econometrica* 55: 251-76.

FAO (Food and Agriculture Organization). 2009a. FAOStat database. Rome.

FAO (Food and Agriculture Organization). 2009b. FAO International Commodity Prices database. Rome. (http://www.fao.org/es/esc/prices/PricesServlet.jsp?lang=en).

FAO (Food and Agriculture Organization). 2009c. FAO Global Information and Early Warning System (GIEWS) Price Tool. Rome. (http://www.fao.org/giews/pricetool/).

FAO (Food and Agriculture Organization). 2009d. "Crop Prospects and Food Situation." No. 2, April. Rome. (http://www.fao.org/docrep/011/ai481e/ai481e04.htm).

Granger, C. and P. Newbold. 1974. “Spurious regression in econometrics.” *Jounral of Econometrics* 60 1045-1066.

Hansen, B. and B. Seo. 2002. “Testing for two-regime threshold cointegration in vector error-correction models.” *Journal of Econometrics* 110: 293 – 318.

Harriss, B. 1979. "There is method in my madness: or it is vice-versa? Measuring agricultural market performance." *Food Research Institute Studies* 16: 97-218.

IMF (International Monetary Fund). 2009. “IMF primary commodity prices.” http://www.imf.org/external/np/res/commod/index.asp

Ivanic, M. and W. Martin. 2008. “Implications of higher global food prices for poverty in low-income countries.” Policy Research Working Paper 4594. The World Bank, Washington, DC.

Kuiper, W., C. Lutz, and A. van Tilburg. 2003. “Vertical price leadership on local maize markets in Benin.” *Journal of Development Economics* 71: 417– 433.

Lazear, E. 2008. “Response to the Global Food Crisis.” Testimony for the Senate Foreign Relations Committee on May 14, 2008 (http://www.whitehouse.gov/cea/lazear20080514.html).

Loening, J., D. Durevall, and Y. Birru. 2008. “Inflation dynamics and food prices in an agricultural economic: The case of Ethiopia.” Policy Research Working Paper No. 4969. The World Bank. Washington, DC.

Meyers, R. 2008. “Evaluating the efficiency of inter-regional trade and storage in Malawi maize markets.” Report for the World Bank. Michigan State University, East Lansing, MI.

Moser, C., C. Barrett, and B. Minten. 2009. “Spatial integration at multiple scales: Rice markets in Madagascar.” *Agricultural Economics* 40: 281–294.

Mundlak, Y. and D. Larson. 1992. “On the transmission of world agricultural prices.” *The World Bank Economic Review* 6 (3): 399-422.

Negassa, A. and R. Myers. 2007. “Estimating policy effects on spatial market efficiency: An extension to the parity bounds model.” *American Journal of Agricultural Economics* 89: 338–352.

Phillips, P.C.B. 1987. “Time Series Regression with a Unit Root.” *Econometrica*, 55: 277-301.

Quiroz, J. and R. Soto. 1995. “International price signals in agricultural prices: Do governments care?” Documento de investigacion #88. ILADES Postgraduate Economics Program. Georgetown University. Santiago, Chile.

Ravallion, M. 1986. “Testing marketing integration.” *American Journal of Agricultural Economics* 68 (2): 292-307.

Rosegrant, M. 2008. “Biofuels and Grain Prices: Impacts and Policy Responses.” Testimony for the U.S. Senate Committee on Homeland Security and Governmental Affairs. May 7, 2008.

SAFEX (South African Futures Exchange). 2009. “JSE SAFEX Agricultural Products” (http://www.safex.co.za/ap/market_price_history.asp).

Sanders, D., S. Irwin, and R. Merrin. 2008. “The Adequacy of Speculation in Agricultural Futures Markets: Too Much of a Good Thing?” Marketing and Outlook Research Report 2008-02, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign (http://www.farmdoc.uiuc.edu/marketing/morr/morr_archive.html).

Schnepf, R. 2008. “High Agricultural Commodity Prices: What Are the Issues?” Report RL34474. Congressional Research Service. Washington, DC. (http://assets.opencrs.com/rpts/RL34474_20080529.pdf).

Staatz, J., N. Dembélé, V. Kelly, and R. Adjao. 2008. "Agricultural Globalization in Reverse: The Impact of the Food Crisis in West Africa" Department of Agricultural, Food and Resource Economics Michigan State University. Background paper for the Geneva Trade and Development Forum, Crans-Montana, Switzerland, September 17-20, 2008. http://www.aec.msu.edu/fs2/srai/Agricultural_Globalization_in_Reverse_MSU_Crans-Montana_paper_final.pdf.

Ulimwengu, J. and R. Ramadan. 2009. "How does food price increase affect Ugandan households? An augmented multimarket approach" Discussion Paper 00884. International Food Policy Research Insititute. Washington, DC.

Ulimwengu, J., S. Workneh, and Z. Paulos. "Impact of soaring food price in Ethiopia: Does location matter?" Discussion Paper 00846. International Food Policy Research Institute. Washington, DC.

Van Campenhout, B. 2008. "Modelling trends in food market integration: Method and an application to Tanzanian maize markets." *Food Policy* 32: 112-127.

Von Braun, J. 2008. "High Food Prices: The What, Who, and How of Proposed Policy Actions." Policy Brief. International Food Policy Research Institute. Washington, DC. (http://www.ifpri.org/PUBS/ib/foodprices.asp).

Weber, M. T., J. M. Staatz, J. S. Holtzman, E. W. Crawford, and R.H. Bernsten. 1988. "Informing food security decisions in Africa: Empirical analysis and policy dialogue." *American Journal of Agricultural Economics* 70 (5): 1044–1052.

Wodon, Q. and H. Zaman. 2008. "Rising food prices in Sub-Saharan Africa: Poverty impact and policy responses." Policy Research Working Paper 4738.. The World Bank. Washington, DC.

World Bank. 2008a. World Development Indicators database. The World Bank. Washington, DC.

World Bank. 2008b. *World Development Report: Agriculture for Development.* The World Bank. Washington, DC.

Appendix A: Characteristics of price data used in econometric analysis

Table A1. Characteristics of international price data

Commodity	Details	Time period	Source
Maize	US 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, 2009b
Wheat	US 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	US No 2 yellow sorghum, FOB Gulf of Mexico	Jan 90 – Dec 08	FAO, 2009b

Table A2. 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
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	Arusha	Maize	Mar-03 - Dec-07
Tanzania	Dar es Salaam	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: 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.