Local Impacts of a Global Crisis

Food Price Transmission and Poverty Impacts in Ghana

Paper presented at the 27th IAAE Conference, Beijing, China
16-22 August 2009

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Abstract

This paper takes a local perspective on global food price shocks by analyzing food price transmission between regional markets in Ghana. It also assesses the impacts of food price increases on various household groups. Taking the recent global food crisis as an example, we find that prices for domestic staples are highly correlated with prices for imported rice. However, price transmission between pairs of domestic regional markets is limited; it is complete for local rice and maize only when more rigorous cointegration analysis is applied. Our findings also show the important role of seasonality in the determination of market integration and price transmission. The welfare effect for households as consumers appears relatively modest at the aggregate national level due to relatively diverse consumption patterns. However, the national average hides important regional differences, both between regions and within different income groups. We find that the poorest of the poor—particularly the urban poor—are the hardest hit by high food prices. The negative effect of the food crisis is particularly strong in northern Ghana. Different consumption patterns, in which grains account for a larger share of the consumption basket in the north compared to the rest of the country, together with much lower initial per capita income levels, are the main explanations for this regional variation in the price effect.

Keywords*:* food crisis, price transmission, cointegration analysis, household model, Ghana

JEL classification: Q13, R20

1. Introduction

From 2007 onward, world food prices surged rapidly, leading to an acute global food crisis in 2008. This food price escalation has highlighted the increasing complexity of the causes and effects of food price shocks in a globalized world and raised serious concerns among policy makers about adverse impacts on the poor in developing countries. Most analysts agree that a mix of rising oil prices, US dollar depreciation, biofuels policies, market speculation and temporarily imposed trade restrictions have all contributed to the rapid surge in food prices (see Headey and Fan 2008 for a review [1]). Several cross-country studies also confirm that the net welfare effect on the world's poor has been negative, mainly due to the high share of net food buyers among the poor (Ivanic and Martin 2008 [2]; Dessus et al. 2008 [3]; Aksoy and Isik-Dikmelik, 2008 [4]).

However, the impacts of surging food prices are often country specific and depend critically on macroeconomic conditions, the country's net international trade position and the food production and consumption patterns of different households groups at the sub-national level. In addition, the degree of price transmission within countries varies widely and critically determines local prices, particularly in more remote parts of a country (Conforti 2004 [5]; Abdulai 2000 [6]; Baffes and Gardner 2003 [7]). Despite the importance of price transmission in determining household welfare effects, only few studies on the 2007/08 global food crisis have included a rigorous price transmission analysis and sub-national regional heterogeneity.[1] Taking price transmission into account is especially important in countries with big regional disparities. For example, the poverty rate is 62.7 percent in Northern Ghana, while it is 28.5 percent at the national level (GSS 2007 [8]). Similarly, the poverty rate of 60.8 percent in Northern Uganda is in stark contrast to 31.1 percent for the country as a whole (UBOS 2006 [9]).

This paper aims to fill this gap in the literature by combining price cointegration analysis with a regionalized household consumption model for Ghana. In the next section we first review major food trade, price and consumption developments in Ghana before and during the 2007/08 food crisis. In section 3, we use a cointegration model to measure the price transmission between international and domestic markets and among different regional markets for major food staples. Based on the findings in Sections 2 and 3, we analyze the impacts of region-specific price

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[1] Arndt et al. (2008) [10] include a simple correlation analysis and find evidence for strong price transmission for Mozambique.

changes on different regional household groups, using a consumption model calibrated to the most recent Ghana Living Standard Survey (GLSSV, 2005/06). Section 5 offers conclusions.

2. Food markets and policies in Ghana

2.1 Food trade and policies

Ghana is largely self-sufficient in major staple crops, yet it depends on imports of wheat and rice to meet domestic demand. About 65 percent of rice consumed domestically (100 percent of wheat) is imported, while imports are negligible for the other major staple crops, such as maize, yam, and cassava (Table 1). Food crops are also negligible in formal exports, yet cross border trade in certain food crops is reported but is hard to measure.[2]

Table 1. Import dependence, production, consumption, and trade for major staples (average of 2004–2006)

Food Items	Domestic Production	Exports	Imports	Domestic Consumption	% Import Dependence
Maize	1,335	0	6	1,340	0.43
Rice	266	0	492	759	65
Wheat	0	0	324	323	100
Millet	152	0	0	152	0.01
Sorghum	294	0	0	294	0.00
Yam	4,229	12	0	4,218	0.00
Cassava	11,062	1	0	11,060	0.00

Note: Production, consumption, and trade are in 1,000 metric tons. Data are simple averages.
Source: Authors' calculations based on data obtained from the Trade Statistics Division of the Ghana Statistical Service (GSS).

Ghana is a relatively open economy with low tariff rates for most commodities. The maximum (ad valorem equivalent of specific tariff) tariff rate was 20 percent in 2007 (World Bank, 2008 [11])[3], which is also the standard rate applied to major food items in Ghana. Moreover, in an attempt to lower domestic food prices, the Ghanaian government has

[2] Cross border informal trade is generally not captured by a country's custom data. While the volume of informal trade is believed quite large in some markets, particularly in Northern Ghana, which often serve as a central market in the region, these trade flows are largely limited to neighboring countries in West Africa such as Niger, Burkina Faso, Togo, and Nigeria. Thus, informal trade may only have limited effects on the transmission of the food crisis to domestic markets in Ghana.

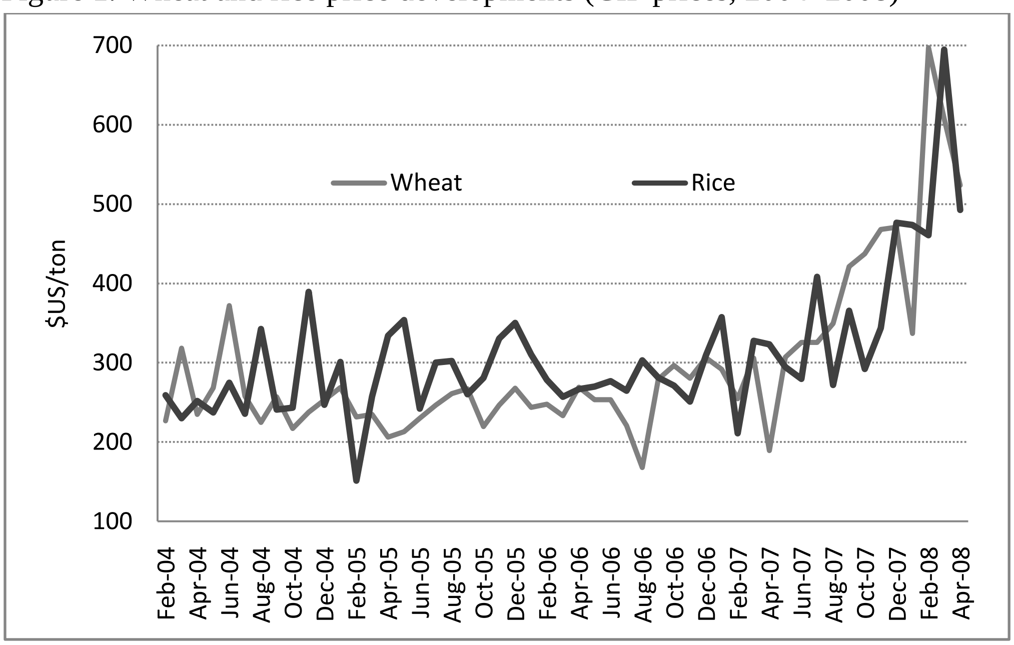
[3] Ghana applies few formal non-tariff barriers. However, in several non-tariff barrier indicators, Ghana is behind its peers. For example, logistical competence is noticeably lower, and inefficient customs and other border procedures are problematic. Relatively high domestic transportation costs also had a negative effect on the country's trade activities (IMF, 2008).

temporarily waived tariffs on imports of rice, wheat, yellow corn and vegetable oil in May 2008 at the height of the food crisis.

In addition to tariff policies and import/export intensities, price transmission is also highly related to hoarding behavior and government stock/export policies, particularly in the short run. However, these factors can be largely ignored in Ghana. Ghana does not have significant public or private capacity to maintain large stocks to deal with unexpected international or domestic shocks. Since the failed attempt to manage its state grain stock system in the 1980s, the country has only once tried (in the case of maize) to build up a state stock as a consequence of an unexpected price shock in 2005–2006. However, the inadequate infrastructural conditions of the warehouses, high electricity costs, and poor management capacity resulted in a huge financial loss and loss of physical stock,[4] which made the government further hesitant to use state-owned stocks as a measure to safeguard against external shocks.

The strong dependence on direct imports of rice and wheat and the lack of storage capacity indicate that the country is vulnerable to world market price fluctuations, and the sharp rise in import prices for rice and wheat in recent years have confirmed this (Figure 1).

Figure 1. Wheat and rice price developments (CIF prices, 2004–2008)



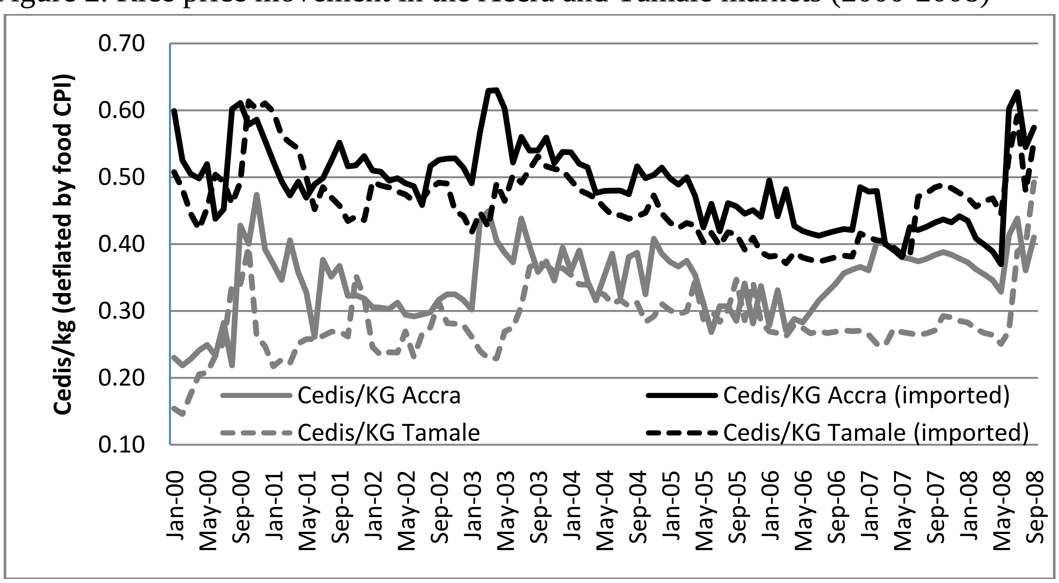
Source: Ministry of Food and Agriculture (MOFA).

[4] Information is based on a May 8, 2008, interview with Aggrey Fynn, the former director of Ghana's agricultural statistics department in the Ministry of Food and Agriculture.

2.2 Food price trends

In this section we further explore how the major imported food item rice might affect locally produced rice prices and prices of non-traded food in Ghana. Figure 2 depicts the rice price trends for imported and local rice in two major markets, Accra, as Ghana's largest consumer market for both imported and local rice, and Tamale, as the supply market for local rice. The movement of prices for local rice generally follows the change in the price for imported rice (Figure 2). While local rice has quality and taste characteristics that are distinct from those of imported rice and is hence not perfectly substitutable with the imported rice (which is relatively cheaper), the markup margin associated with it together with trade and transport costs was quite constant in both markets before the food crisis. Moreover, the difference between the two markets' prices for imported rice is relatively smaller than the difference between their prices for local rice. However, a different pattern in price movements can be observed during 2007 and 2008 when the world rice price significantly increased (Figure 2). While the price for local rice in the Accra market rose to the level of imported rice in May–July 2007, a lean season in the country, its movement became relatively flat after that. In contrast, the gap between prices for local rice and for imported rice in the Tamale market widened during this period, compared to historical trends.

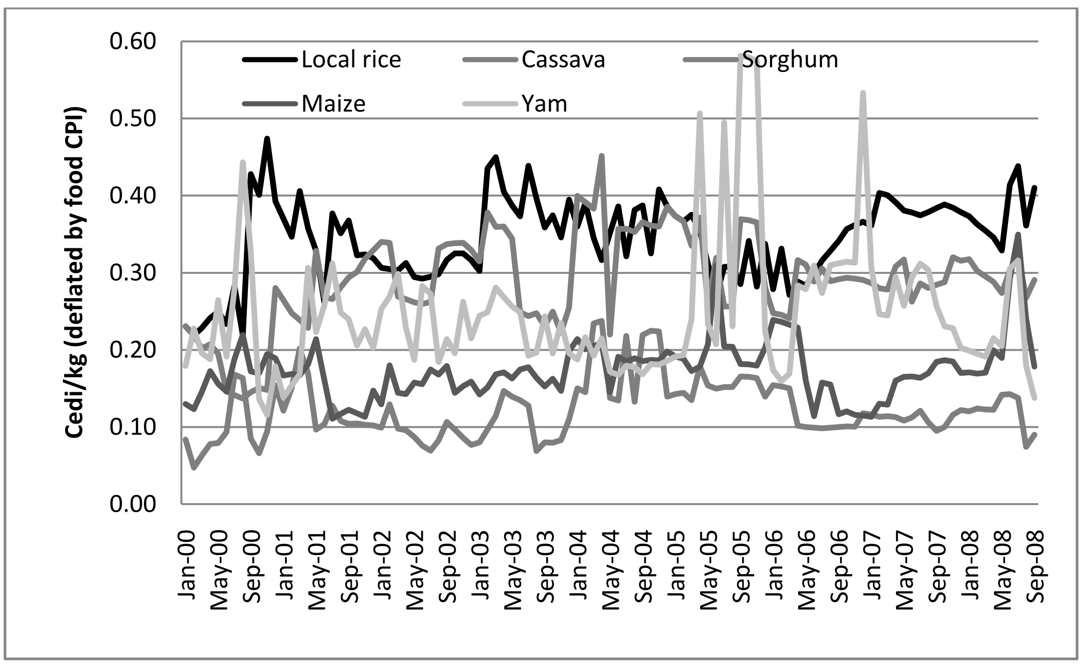
Figure 2. Rice price movement in the Accra and Tamale markets (2000-2008)



Source: Authors' calculations using data obtained from Ghana Statstical Service (GSS) (2008).

Yet, the effect on local prices also hinges on the question, in how far high world market prices for other (non-traded) food commodities spill over to local markets. Substitution in consumption between rice and local staples such as maize, cassava, and yam may cause domestic prices for nontradable products to rise when the world prices for imported food products increase. The trends depicted in Figure 3 suggest that prices for all staple products have a tendency to move together in recent history, with a short exceptional period in 2006, particularly for maize. However, after the maize price decline in 2006, a year in which maize and rice prices moved in opposite directions, the maize price started to increase again in 2007 and 2008, moving in the same direction as rice prices. Prices for cassava and sorghum follow a similar trend to that of rice prices in late 2007 and 2008, while yam prices started to increase only in 2008.

Figure 3. Price movement for major crops in the Accra market



Source: Authors' calculations using data obtained from the Ghana Statstical Service (GSS) (2008).

2.3. Food consumption patterns

Consumption patterns in Ghana vary substantially across different income groups and regions. In contrast to many South and Southeast Asian countries, where rice as a single product often makes up the lion's share of staple food consumption, particularly for poor households, Ghana, like many other West African countries, has a much more diverse diet among both rural and urban households. Calculations from the recent household survey (GLSSV 2005/06) show that grain and root/tuber consumption together account for about 28 percent of total food expenditure for an average Ghanaian. Spending on staple food (including the consumption of own production) is almost equally distributed between grain products (maize, rice, wheat, sorghum) and roots and tubers (cassava, yam, cocoyam). This consumption pattern applies to both rural and urban households, while the share of grain and root staples together accounts for a much larger share (33 percent) of total spending in rural areas.

Across different regions in the country, however, household food consumption structures vary, both in rural and urban areas. Roots and tubers are more important as staples in three of four agro-ecological zones, Coastal, Forest, and Southern Savannah (particularly for rural households), while in the Northern Savannah zone (which includes three administrative regions: Northern, Upper East, and Upper West), the share of grain consumption is much higher than the share of roots/tubers (Table 2, second part). Moreover, poor households generally spend more of their income on staples. With more than 60 percent of households in the Northern Savannah zone (hereafter referred to as "the north") living below the national poverty line, northern households spend a much higher proportion of their income on food than do the households in the rest of the country (Table 2, first part). These two factors together (i.e., more grain consumption and more spending on food in the north) indicate that poor northern households are more vulnerable to rising world food prices, which have particularly surged for grain products. In Section 4 we quantitatively measure this impact using a household model.

Table 2. Household expenditure structure across agro-ecological zones

	Total Expenditure			**Food Expenditure**			
	Food	Other	Total	Grains	Roots	Other Food	Total Food
Rural							
Coastal	62.0	38.0	100	12.9	14.8	72.2	100
Forest	57.5	42.5	100	11.3	17.3	71.4	100
S. Savannah	65.5	34.5	100	16.4	29.7	53.9	100
N. Savannah	70.3	29.7	100	26.8	12.0	61.2	100
Urban							
Coastal	41.1	58.9	100	9.4	8.1	82.5	100
Forest	47.5	52.5	100	11.2	11.7	77.1	100
S. Savannah	53.5	46.5	100	11.8	17.7	70.5	100
N. Savannah	51.4	48.6	100	24.2	9.4	66.4	100

Source: Authors' calculations using data from GLSSV 2005/06.

While the poor consume proportionally more food as a share of their income, some households, particularly rural households, meet part of their food consumption by own production. The impact of rising food prices on the consumption levels of households whose consumption is primarily met by their own production is expected to be smaller than the impact on households relying on food purchases from markets. Therefore, we report the share of own-production and purchased staples[5] separately in Table 3, together with the share of other food and food in total expenditure by 10 income groups in both rural and urban areas.

Results show that staples, either own produced or purchased from markets, account for a larger share of spending for poor households in the first two decile groups compared to other household groups. However, compared with rural households, shares of purchased staples are generally larger for urban households, particularly for urban poor households in the first two decile groups. These consumption patterns, which indicate that rising food prices may affect urban households more than rural households, will be further analyzed in Section 4.

[5] We consider only grains (including maize, rice, wheat, sorghum, and other grains that cannot be identified) and roots/tubers as staples and group other foods such as pulses, oilseeds, vegetables, fruits, and livestock products into an "other food" category in our analysis.

Table 3. Food consumption share by income groups

	Staples			
	Own Production	Purchased	Other Food	Food in Total Spending
Rural				
The poorest	28.3	16.2	55.6	65.4
2nd	24.4	13.7	61.9	64.7
3rd	24.1	13.3	62.6	66.2
4th	21.5	14.3	64.2	64.4
5th	21.9	13.4	64.7	64.2
6th	18.9	14.2	66.9	64.2
7th	18.9	13.0	68.1	63.6
8th	18.3	13.2	68.5	60.5
9th	16.2	14.0	69.8	62.3
The richest	11.3	12.0	76.7	54.6
Urban				
The poorest	17.5	19.8	62.8	54.8
2nd	9.9	17.5	72.7	54.8
3rd	8.4	21.6	70.0	53.5
4th	6.8	22.0	71.2	54.7
5th	6.9	20.6	72.5	55.0
6th	4.1	21.0	74.9	53.6
7th	3.6	20.8	75.6	52.9
8th	2.8	19.5	77.7	51.5
9th	3.1	18.3	78.6	49.6
The richest	1.5	15.7	82.8	36.1

Note: The national poverty rate is 28 percent in the survey, which indicates that most households are poor in the first three groups and extremely poor in the first two groups.
Source: Authors' calculations using data from GLSSV 2005/06.

3. Food Price Transmission in Ghana

To quantitatively assess local impacts of global food price shocks we start by conducting a correlation analysis between world market prices of the main imported food commodity rice and prices for local staple crops (local rice, maize, cassava, and yam) within each of the six wholesale markets in order to test whether local staple products are sensitive to changes in the price of imported rice. We then use standard cointegration analysis to test whether the price transmission, if it exists, occurs uniformly in the different local markets.

Results of the correlation analysis show that the value of the partial correlation coefficient is higher between world prices of rice and prices of local food staples in markets located in the poorest northern regions (Wa and Tamale), indicating that their staple food prices have the highest significant positive correlation with world prices of rice (Table 4). However, the correlation value is also relatively high between the world prices of rice and maize. We find a high and significant correlation for these two products' prices in the market located in the country's major maize consumption areas (Accra, Wa, and Mankesim). While both cassava and yam are traded within the country, their trade patterns are rather seasonal. Consistent with these trading patterns, the prices for these two products are less correlated with the price for world market price of rice.

Table 4. Pairwise correlation coefficient between real prices of imported rice and local products

	Local Rice	**Maize**	**Cassava**	**Yam**
Accra	0.119	0.4092*	-0.050	-0.085
Sunyani	0.2455*	0.185	-0.175	0.013
Tamale	0.2083*	0.1933*	0.2345*	-0.001
Kumasi	0.4821*	-0.129	-0.269*	0.059
Mankesim	0.141	0.3589*	-0.128	-0.030
Wa	0.4206*	0.4042*	0.2148*	0.5163*

* Significance at 5% level
Source: Authors' calculations using monthly market data for January 2000 to September 2008 obtained from the Ghana Statistical Service (GSS) (2008) [12].

We now turn our attention to the price relationship across markets within Ghana. We test the order of integration of each price series and the cointegration of each major staple food commodity between every pair of markets and also simultaneously across all major markets in Ghana. Following a general vector error correction specification, we also test price transmission of cointegrated prices between major food markets in Ghana.

Most price transmission analyses are based on the "law of one price" theory, in which an equilibrium price among spatially separated markets exists as defined by Enke (1951) [12], Samuelson (1952) [13], and Takayama and Judge (1971) [14]. This price relationship can be defined as follows[6]:

(3.1) $$P_{i1} = P_{i2} + T_{i21}$$

[6] Existing methods of testing price transmission include the law of one price in Richardson (1978) and the Ravallion model (Ravallion 1986). Ravallion estimates a dynamic model that accounts for the possible cointegration of prices in an error correction setting. However, the model does not allow for the interaction between all prices, and it estimates different cointegrated equations separately. Therefore, the methodology misses an important layer of information that stems from the likely interaction between prices of the same commodity in different cointegration equations.

where P_{i1} and P_{i2} are the prices of commodity *i* in two spatially distinct markets 1 and 2, T_{i21} is a multiplicative markup factor including the cost of transporting a unit of the commodity from market 2 to market 1. All are in logarithmic form. This specification is still widely used in price transmission analyses, including those of Ravallion (1986) [15], Barret 2001 [16], Baulch 1997 [17] and Asche, Jaffry, and Hartmann (2007) [18].

As prices typically exhibit unit roots, we test the level of integration of each price series using the Augmented Dickey-Fuller (ADF) test. Given that we found that all our price series are of order one, I(1), first differences of the unrestricted vector autoregressive (VAR) of some finite order p would be an appropriate starting point based on the notions of general-to-specific modeling (Hendry 1995) [19]. Accordingly, the following equation holds:

(3.2) $$y_t = \mu + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p}$$

However, Granger (1983) [20] notes that cointegrated systems have an error correction representation that would be missing if the first differences were modeled in equation (3.2). Hence, we further derive our error correction mechanism from Engle and Granger (1987) [21] as:

(3.3) $$\Delta P_t = \mu + \Pi P_{t-1} + \sum_{k=1}^{q-1} \Gamma_k \Delta P_{t-k} + \varepsilon_t$$

where Π is a matrix such that $\Pi = \alpha\beta'$. In addition, we use a multivariate specification of the vector error correction mechanism (VECM). In this way, we include cointegrated price pairs of the same commodity in different market pairs. This multivariate specification allows both short- and long-run changes in the price of a commodity in one market to potentially translate into changes in the price for the same commodity in the other markets.

To understand equation (3.3) and thereby demonstrate the interpretation of price transmission and the speed of adjustment toward equilibrium after a deviation, we consider a system with only a pair of prices: the price of a commodity in region a, P^a, and in region b, P^b. Assuming that these prices are integrated of order one; that is I(1) and cointegrate, then equation 3.3 represents this cointegrated system in matrix notation as follows:

(3.4) $$\begin{bmatrix} \Delta p_t^a \\ \Delta p_t^b \end{bmatrix} = \underbrace{\begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix}}_{A'} \underbrace{\begin{matrix} \beta_1 & \beta_2 \end{matrix}}_{B'} \begin{bmatrix} p_{t-1}^a \\ p_{t-1}^b \end{bmatrix} + \sum_{i=1}^{q-1} \Gamma_i \Delta P_{t-i} + u_t$$

where q is the lag length[7] of the underlying VAR. Usually, β_1 is normalized to 1, while a realization of $\beta_2 = -1$ indicates complete price transmission. α_1 and α_2 indicate the respective rates at which P^a and P^b adjust after disequilibria. In the two-price system shown in (3.4), we have one cointegration equation and need a minimum of only one restriction in the cointegration space. However, in a general multivariate system with r cointegrating equations, at least r^2 restrictions are required (Johansen 1995) [22]. In our analysis there are two cointegrating equations in each of the models we present, which means that we must impose at least four restrictions for each model. More specifically, in this study, as all price series were found to be I(1), cointegration tests have been conducted for individual staple food products (local rice, maize, cassava, and yam) in each pair of local markets (six markets in total).

We first found no evidence of cointegration in any market pair for cassava and yam, indicating that prices for these two products may be locally determined. For both local rice and maize, we found evidence of two sets of cointegrated prices in the local markets. Based on these two cointegrated price sets we further tested for cointegration in a larger dimension, due to the choice of a higher VECM dimension using the framework developed by Johansen (1988, 1991, 1995) [23,24,22]. Moreover, the critical issues in VECM are the cointegrating vector and speed of adjustment parameters, which are key for characterizing the extent of price transmissions and the disequilibrium behavior of prices, respectively. As these hinge critically on cointegrated prices, cointegration test results are reported in Table 5a.

[7] In choosing the lag length, we paid particular attention to Hannan-Quin and Schwartz criteria, as they are consistent, particularly in large samples (Paulson 1984; Tsay 1984; Lutkepohl 2005).

Table 5a. Johansen cointegration tests

Markets: Accra, Mankesim, and Techiman (Maize)		
Trend: Constant		
Maximum rank	Eigenvalue	Trace statistic
0	.	34.3503
1	0.22813	16.2243
2	0.16631	3.4920**
3	0.04866	
Markets: Accra, Tamale, and Wa (Local Rice)		
Trend: Constant		
Maximum rank	Eigenvalue	Trace statistic
0	.	39.8648
1	0.21886	15.4124
2	0.11733	3.0565**
3	0.0304	
Markets: World Prices, Mankesim, and Wa (Imported Rice)		
Trend: Constant		
Maximum rank	Eigenvalue	Trace statistic
0	.	48.5661
1	0.284	15.8301
2	0.1329	1.8550*
3	0.0188	

** Significance at 5% level

The results reveal potential price transmission across local markets for rice and maize, while the markets for cassava and yam remain highly localized. The first part of Table 5a reports the cointegration test for maize in the three local markets, while the second part of the table reports the results for local rice in the other three markets.

The ranks (0–3) in Table 5a represent the different null hypotheses: no cointegration (with rank 0), one or fewer cointegration equations (with rank 1), two or fewer cointegration equations (with rank 2), and so on. We use Johansen's test procedure, in which the trace statistic, the key result of this test, is computed from the eigenvalue. The hypotheses of no cointegration and one or fewer cointegration equations are both rejected, while the hypothesis of two or fewer cointegration equations is not rejected, implying two sets of cointegration equations for local rice and maize.

The results of the VECM for the prices of maize and local rice in the three respective markets are reported in Table 5b. In assessing model stability, Lagrange multiplier (LM) tests were conducted for residual autocorrelation, which shows that the null hypothesis of no autocorrelation cannot be rejected in both models for local rice and maize. In Table 5b, complete price transmission is characterized by β = -1 in the VECM, in line with the explanation following equation (3.4). We observe here that the estimated beta values for the first cointegration equations in both models are close to -1. -1 lies in their respective 95% confidence interval, suggesting complete price transmission.

We confirm this by imposing appropriate restrictions[8] in the cointegration space along the lines of Johanson's (1995) [22] overidentifying restrictions. The P value for null (β = -1) in Table 5b reports the P value of the likelihood ratio test for our restrictions. P values greater than 0.05 are evidence that we are unable to reject the null hypothesis that β = -1 at a 5% level of significance, and so price transmission is complete. Following a similar scheme, we also tested for complete price transmission in the market pairs in the second cointegration equations for both models. As reported in Table 5b, the estimated beta values in the second cointegration equations are not as close to -1 as those in the first cointegration equations. Also, -1 does not lie in their respective 95% confidence intervals, suggesting incomplete price transmission. We confirm this with a likelihood ratio test, as with the first cointegration equations. The P values for the null hypothesis that β = -1 is rejected at a 5% level of significance, as the P values are less than 0.05.

The alphas depict speed of adjustment in restoring equilibrium after disequilibria. For the first cointegration equation of the maize price model (Table 5b), Accra maize prices adjust by reducing 12.3% of the amount of disequilibria, while Techiman maize prices increase by 28.5% of the disequilibrium amount. In the second cointegration equation for the same model, the adjustment rates are reductions of 75% and 15.1% in Mankesim and Techiman, respectively. In the local rice model, the adjustment rates are a 26.7% decrease in Tamale prices and a 1.4% increase in Accra prices for the first cointegration equation. For the second, the adjustment rates are a 35.2% reduction in Wa prices and a 28.1% increases in Accra prices. The short-run dynamics here show that short-run price impacts are highest in producing markets.

[8] Notice that the price series were arranged to ensure that the restrictions were consistent with the identified cointegrated price pairs.

We also considered seasonality in our tests. By controlling for seasonality, we observed that for the first six months of the year before the harvest season, average monthly maize prices are 4.2 percent higher than those in the second half of the year in the Accra market, 3.1 percent higher in the Mankesim market, and 18.0 percent higher in the Techiman market. Thus, seasonality has a much larger impact in Techiman, a major supply market, than in Accra and Mankesim, the two major consumer markets.

The findings of the series of econometric tests conducted in this section confirm the heterogeneity of price transmission in Ghana, and hence the different extents to which world food prices are passed on to local markets. We have shown that price transmission is high for grain products, both in the short and long run, while for root crops such as cassava and yam no evidence of price transmission is found across different regional markets. In the next section, we develop a simple household model, based on the analysis in Sections 2 and 3, to show how these locally diverse price changes affect different household groups in Ghana.

Table 65b: Vector error correction mechanism (VECM) results

MODEL 1: Results for cointegrated maize prices						
	1st cointegration equation (Techiman & Accra)			2nd cointegration equation (Mankesim & Techiman)		
	Techiman(α)	Accra(α)	*β*	Mankesim(α)	Techiman(α)	*β*
Estimated value	0.285**	-0.123	-.940***	-0.751***	-0.151	-.575***
95% lower CL**[introduce?]**			-1.245			-0.778
95% upper CL			-0.635			-0.372
P value for null (β = -1)			0.773			0.038
MODEL 2: Results for cointegrated local rice prices						
	1st cointegration equation (Tamale & Accra)			2nd cointegration equation (Wa & Accra)		
	Tamale(α)	Accra(α)	*β*	Wa (α)	Accra(α)	*β*
Estimated value	-0.267***	0.014	-.868***	-0.352***	0.281**	-.754***
95% lower CL			-1.081			-0.929
95% upper CL			-0.653			-0.58
P value for null (β = -1)			0.264			0.037
MODEL 3: Results for cointegrated imported rice prices						
	1st cointegration equation (world prices & Accra)			2nd cointegration equation (world prices & Wa)		
	World prices(α)	Mankesim(α)	*β*	World prices(α)	Wa(α)	*β*
Estimated value	-0.0196	-0.3029***	-0.847***	0.033	-0.3902***	-.568***
95% lower CL			-1.0677			-0.7279
95% upper CL			-0.6256			-0.4077
P value for null (β = -1)			0.212			0.001

*** Significance at 1% level

** Significance at 5% level

4. Welfare Impacts of Food Price Shocks

Surging world food prices are expected to hit the poor as consumers directly and immediately, since staple food forms the most important part of their daily diet. However, with a diverse diet structure in calorie intake, households may temporarily switch away from those grain products for which world prices have risen significantly and consume more roots and tubers, given that market supply for those alternative staples exists. In this case, domestic prices for commodities that are not internationally traded, such as cassava and yam in Ghana, might rise through substitution effects. To assess how consumers, particularly poor consumers, will be directly affected by rising world food prices, we develop a partial equilibrium model that considers consumer demand for food products. In the model, demand for each food product is a function of prices and income:

(4.1) $$c_i = \prod_j p_j^{\varepsilon_{i,j}} Y^{\varepsilon_i^I}$$

where $\varepsilon_{i,j}$ represents the price elasticity and ε_i^I the income elasticity. A two-stage approach is used to derive these elasticities. We first estimate the income elasticity for each individual food product using the most recent household survey available for Ghana (GLSSV 2005/06). The income elasticities are estimated for different population groups by rural and urban location. We then calculate price elasticities by considering a demand system that is solved from a Stone-Geary (SG) utility function:

(4.2) $$U(c_1, c_2, \ldots c_N) = \prod_j (c_j - \gamma_j)^{\beta_j}$$

(4.3) $$\text{subject to } \sum_{i=1}^{N} p_i \cdot c_i = Y$$

In equations (4.2) and (4.3), $U(\cdot)$ is the utility function, c_i is the total quantity of demand for good *i*, γ_i is the subsistence level of good *i*, β_i is the marginal budget share (not the average budget share) of good *i*, p_i is the price for *i*, and *Y* is the income. We chose the consumption of own production for good *i* as γ_i and solved a linear expenditure demand system from equations (4.2) – (4.3). With this demand system, together with expenditure share data, the assumption that γ_i equals the home consumption data and estimated income elasticities, the price elasticity of demand can be calculated. We then apply these elasticities to equation (4.1) such that the price (both own and cross prices) and income effect on the demand for 28 food commodities can be explicitly measured. The average income elasticities for all crops by income quintile groups and rural and urban locations are reported in Table A.1 in the appendix.

The shock imposed on the model is a one-time change in the domestic prices for maize, rice, wheat, sorghum, cassava, and yam that is based on the country's monthly price changes from April 2007 to April 2008 and defined at the regional level. That is, we applied the actual price increase in the six main markets for which information is available to the households in the corresponding regions. For the regions where market price information is not available, we use the changes in the prices of neighboring regions within the same agro-ecological zones as a proxy. We consider the effect on consumers only and omit the possible effect on rural households as food producers in the analysis because of data constraints.[9]

Results show that at the national level and weighted by base-year prices, total staple consumption (including both own-production and purchased staples) falls by 7.1 percent for rural and 9.3 percent for urban households (Tables 6 and 7). This decline is due to the reduced consumption of purchased food, while consumption of own-production food is assumed to remain unchanged. The total consumption effect at the national level is -7.9 percent.

Urban consumers are more negatively affected than are rural consumers in terms of declines in staple consumption. This can be explained by the fact that the share of purchased food in total staples consumed by urban households is much higher than for rural households. As shown in Section 2, purchased products account for 85 percent of grains and roots consumed by urban households, but only 41 percent for rural households. Because of this, rural households' consumption is less price sensitive than is urban households' consumption, as rural households can rely on their own production for a large share of consumption, even when food purchases are reduced by a similar amount to urban households' reductions.

[9] The quality of production data by individual crops is poorer than that of consumption data. Therefore, we decided not to identify net sellers or buyers in the analysis. While supply response and income effect are important topics in analyzing the food price crisis, given that the focus of the paper is on short-term effects, such analysis is beyond the scope of this paper.

Table 6. Percentage change in grain and root consumption—rural households

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Total
Coastal	-6.9	-6.9	-6.5	-7.6	-7.9	-7.3	-6.9	-7.1	-8.9	-8.7	-7.8
Forest	-5.7	-6.4	-5.6	-5.6	-5.6	-5.4	-5.6	-5.8	-6.7	-7.8	-6.1
S. Savannah	-4.1	-2.7	-3.0	-3.3	-3.9	-3.2	-3.1	-3.5	-4.7	-4.3	-3.4
N. Savannah	-9.6	-9.1	-9.6	-9.5	-8.0	-9.6	-9.1	-9.2	-11.4	-8.0	-9.4
National	-9.2	-7.4	-6.8	-6.5	-6.5	-6.5	-6.3	-6.2	-8.1	-7.8	-7.1

Note: D1 represents the first decile, with the lowest level of income, and D10 represents the decile with the highest level of income.
Source: Household simulation model results.

Table 7. Percentage change in grain and root consumption—urban households

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Total
Coastal	-15.6	-21.7	-12.7	-14.2	-10.7	-9.5	-9.1	-9.2	-6.0	-5.7	-7.7
Forest	-30.5	-19.0	-12.3	-13.3	-11.7	-11.1	-10.6	-10.6	-6.7	-7.2	-9.3
S. Savannah	-13.0	-14.2	-8.0	-6.8	-7.6	-8.6	-7.5	-8.3	-5.3	-5.4	-7.1
N. Savannah	-20.0	-21.7	-20.1	-19.5	-16.8	-14.6	-14.9	-15.9	-10.3	-12.1	-15.6
National	-19.8	-19.8	-14.3	-14.8	-12.0	-10.8	-10.6	-10.7	-6.7	-6.5	-9.3

Note: D1 represents the first decile, with the lowest level of income, and D10 represents the decile with the highest level of income.
Source: Household simulation model results.

Food consumption falls more for poor households and poor urban consumers are hit hardest by price increases. At the national level, staple consumption declines by 20 percent for the poorest urban households in the first two decile groups (Table 6, the last row), while it declines by 9.2 and 7.4 percent, respectively, for the rural households in the same two decile groups.

At the subnational level, the poorest urban households in the Forest zone are most negatively affected, as their staple consumption falls by 30.5 percent, followed by the poor urban households in the Coastal zone (group 2) and in the Northern Savannah zone (groups 1–3), with a decline of more than 20 percent. In rural areas, almost all households in the Northern Savannah zone are badly hurt by the rising prices, as the declines in their staple consumption are almost the same (between 8 percent and 11.4 percent, but most are around 9 percent). This result is consistent with what we expected and explained in Section 2. As almost 70 percent of rural households in the Northern Savannah are living below the poverty line, and also as households in the north consume proportionally more grains than root products, they are more vulnerable to shocks and find it more difficult to adjust their consumption patterns by switching to the consumption of other staples.

In addition to the negative effect on those whose income is already below the poverty line[10], some households that are not poor according to their current income may fall into poverty, and hence the number of poor in Ghana may increase due to the food price increase. While more in-depth analysis on the potential increase in the number of poor is important for assessing the economywide impacts of rising food prices, this paper focuses on the low-income groups. The important message of this analysis is that the poorest of the poor are hurt the most when food prices rise, and their capacity to cope with the food crisis by themselves is most limited. These people therefore need immediate and properly designed government response programs.

5. Conclusions

This paper has taken a local perspective on global food price shocks by analyzing price transmission between global, national and regional markets in Ghana. It has also used region-specific price changes of major traded and nontraded food commodities to assess the impacts of the 2007–2008 food crisis on different household groups.

Ghana is highly dependent on wheat and rice imports, for which world market prices have risen sharply during the food crisis. In addition, the capacity to hedge against price fluctuations is limited in the country by the lack of physical storage facilities, both for the government and for the private sector. However, the country is largely self-sufficient in many other staple foods such as maize, cassava, and yam. Moreover, the domestic market structure for both production and consumption is heterogeneous across regions. These factors, together with different consumption patterns across different income groups, indicate that rather heterogeneous and complicated local welfare effects occur from a world food price increase.

We found that prices for domestic staples are highly correlated with the price for imported rice within each regional market, particularly in the case of local rice and maize prices. However, complete price transmission across a pair of regional markets is found in the case of local rice and maize only when a more rigorous cointegration method is applied. This finding indicates that market integration and hence price transmission is highly heterogeneous for

[10] According to the GSS (2007) and based on GLSSV data, the national poverty rate was 28.5 percent in 2005/06 in Ghana, with rates of 39.2 percent in the rural areas and 10.8 percent in the urban areas.

different food crops and different regional markets. The seasonality factor is found to play an important role in the determination of market integration and price transmission. Even for those commodities with complete price transmission, we found strong price volatility, particularly in the producer markets for the respective commodity.

The welfare effect for households as consumers is relatively modest at the national aggregated level. The modest impact can be explained primarily by the relatively diverse consumption patterns, in which root crops account for a large share of staple foods. However, this national average hides important regional diversity in the welfare effect both across regions and between different income groups. By disaggregating households into different income groups across regions, we find that the poorest of the poor, especially poor urban households, are the hardest hit by high food prices. At the regional level, the negative effect of the food crisis is particularly severe in northern Ghana. Different consumption patterns, in which grains account for a larger share of the consumption basket in the north compared to the rest of the country, together with much lower initial per capita income levels in the north, are the main explanations for this regional variation in the price effect.

Figure A.1. Map of Ghana's major markets

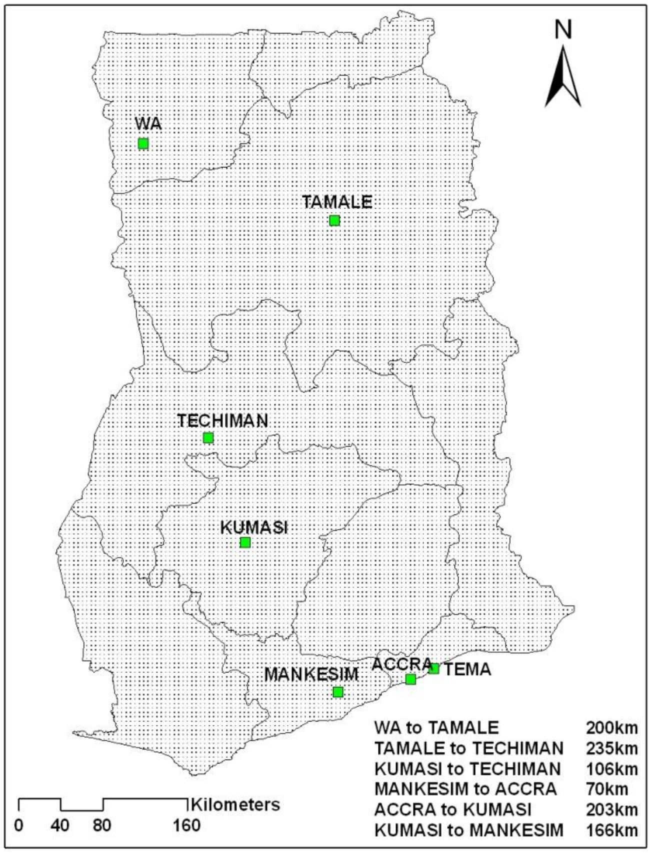


Table A.1 Rural and urban income elasticities

Rural income elasticity

	cmaiz	crice	csorg	cogrn	ccass	cyams	ccyam	croot	ccpea	csbea	cpoil	cgnut	conut	cfrud	cvegd	cplan	cocro	cchik	ceggs	cbeef	cgoat	coliv	cfish	csupr	cdair	cmeat	cforf	clocf
DEC1	0.27	0.83	0.53	0.83	0.50	0.50	0.50	0.50	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	2.89	2.89	1.12	1.12	1.12	1.13	1.66	0.67	1.06	1.7	0.7
DEC2	0.27	0.83	0.53	0.83	0.50	0.50	0.50	0.50	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	2.89	2.89	1.12	1.12	1.12	1.13	1.66	0.67	1.06	1.7	0.7
DEC3	0.37	0.65	0.70	0.65	0.43	0.43	0.43	0.43	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	1.62	1.62	0.88	0.88	0.88	1.03	1.27	0.59	0.90	1.3	0.6
DEC4	0.37	0.65	0.70	0.65	0.43	0.43	0.43	0.43	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	1.62	1.62	0.88	0.88	0.88	1.03	1.27	0.59	0.90	1.3	0.6
DEC5	0.45	0.64	0.75	0.64	0.43	0.43	0.43	0.43	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	1.40	1.40	0.76	0.76	0.76	1.02	1.08	0.55	0.81	1.1	0.6
DEC6	0.45	0.64	0.75	0.64	0.43	0.43	0.43	0.43	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	1.40	1.40	0.76	0.76	0.76	1.02	1.08	0.55	0.81	1.1	0.6
DEC7	0.44	0.58	1.13	0.58	0.43	0.43	0.43	0.43	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	1.11	1.11	0.65	0.65	0.65	0.99	0.89	0.53	0.81	0.9	0.5
DEC8	0.44	0.58	1.13	0.58	0.43	0.43	0.43	0.43	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	1.11	1.11	0.65	0.65	0.65	0.99	0.89	0.53	0.81	0.9	0.5
DEC9	0.50	0.62	0.97	0.62	0.51	0.51	0.51	0.51	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.82	0.82	0.66	0.66	0.66	1.00	0.75	0.56	0.76	0.7	0.6
DEC10	0.50	0.62	0.97	0.62	0.51	0.51	0.51	0.51	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.82	0.82	0.66	0.66	0.66	1.00	0.75	0.56	0.76	0.7	0.6

Urban income elasticity

	cmaiz	crice	csorg	cogrn	ccass	cyams	ccyam	croot	ccpea	csbea	cpoil	cgnut	conut	cfrud	cvegd	cplan	cocro	cchik	ceggs	cbeef	cgoat	coliv	cfish	csupr	cdair	cmeat	cforf	clocf
DEC1	0.80	1.78	0.17	1.78	2.03	2.03	2.03	2.03	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	2.89	2.89	1.43	1.43	1.43	1.61	1.25	1.20	0.94	1.2	1.2
DEC2	0.80	1.78	0.17	1.78	2.03	2.03	2.03	2.03	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	2.89	2.89	1.43	1.43	1.43	1.61	1.25	1.20	0.94	1.2	1.2
DEC3	0.85	1.22	0.39	1.22	1.05	1.05	1.05	1.05	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.97	1.97	0.98	0.98	0.98	1.25	1.13	1.06	0.90	1.1	1.1
DEC4	0.85	1.22	0.39	1.22	1.05	1.05	1.05	1.05	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.97	1.97	0.98	0.98	0.98	1.25	1.13	1.06	0.90	1.1	1.1
DEC5	0.77	0.90	0.68	0.90	0.96	0.96	0.96	0.96	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.46	1.46	0.86	0.86	0.86	1.40	1.04	0.92	0.90	1.0	0.9
DEC6	0.77	0.90	0.68	0.90	0.96	0.96	0.96	0.96	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.46	1.46	0.86	0.86	0.86	1.40	1.04	0.92	0.90	1.0	0.9
DEC7	0.71	0.83	0.51	0.83	0.82	0.82	0.82	0.82	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.10	1.10	0.75	0.75	0.75	1.65	0.92	0.79	0.88	0.9	0.8
DEC8	0.71	0.83	0.51	0.83	0.82	0.82	0.82	0.82	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.10	1.10	0.75	0.75	0.75	1.65	0.92	0.79	0.88	0.9	0.8
DEC9	0.48	0.51	0.27	0.51	0.59	0.59	0.59	0.59	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	0.95	0.95	0.60	0.60	0.60	2.23	0.64	0.58	0.91	0.6	0.6
DEC10	0.48	0.51	0.27	0.51	0.59	0.59	0.59	0.59	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	0.95	0.95	0.60	0.60	0.60	2.23	0.64	0.58	0.91	0.6	0.6

Source: Authors’ estimates using data from GLSSV.

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