How Strong Do Global Commodity Prices Influence Domestic Food Prices in Developing Countries? A Global Price Transmission and Vulnerability Mapping Analysis

12

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12.1 Introduction

Major global food commodities experienced unexpected price spikes in 2007/2008 and again in 2010. This raised serious concerns about the impact of global price shocks and volatility on food security in developing countries. There have been several attempts to investigate the impacts of price shocks on income and poverty as well as nutrition indicators. Some of these papers quantified the number of people who were pushed below the poverty line due to increased food prices (and decreased real incomes) at 105–150 million (de Hoyos and Medvedev 2011; Ivanic and Martin 2008); Tiwari and Zaman (2010) estimated that 63 million people became food insecure, as measured by the number of people who consume less than 1810 calories/day. However, as these studies used either domestic food prices, whereby the linkage to global prices is not directly clear (de Hoyos and Medvedev 2011), or the ad hoc assumption that price transmissions from global markets are uniform (Ivanic and Martin 2008; Tiwari and Zaman 2010), they cannot provide a satisfactory answer about the impacts of global price shocks. The heterogeneous degree of price transmission from international to domestic markets has to be considered explicitly for ex-post impact analysis as well as early warning and information systems, which are aimed at identifying upcoming food security risks.

There are some controversies about the role of international commodity prices in the local food security of developing countries. A common explanation for the low integration of developing countries, in particular African countries, in

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global markets is that many of them import only small amounts of the commodity they consume and that trade does not take place continuously. Additionally, transaction costs due to transportation costs and trade barriers, like tariffs and quotas, are considered to reduce price transmission. Existing research has therefore come to different conclusions regarding the degree of price transmission, depending on the considered domestic market, crop and international reference price.

So far, a comprehensive analysis of the extent of price transmission for the 1.2 billion people worldwide living below the poverty line is missing: We neither have an estimation of how many poor people are affected by global market-induced food price changes nor do we know the heterogeneous extent of price transmission. While the recent FAO report on the State of Food Insecurity in the World (FAO 2013) attempted to provide an aggregate picture of the extent of price transmission, it used regionally aggregated food price indices which showed only weak linkages to global prices and price volatility.[1] The use of regionally aggregated price indices, however, masks the heterogeneity of countries and commodities: combining prices from markets with high market integration and low (or missing) market integration will give an average low transmission that distracts from the serious impacts of international price shocks on *some* markets.

This paper aims to fill this gap by providing a globally comprehensive but nationally differentiated analysis of price transmission which maps transmission elasticities to the size of the vulnerable population. The result will be a Lorenz-type curve showing how many poor people are affected by international price shocks and how strong these effects are. The paper also provides a pragmatic way to deal with the heterogeneity of local food staples by creating a domestic grain price index which is highly relevant to the poor and vulnerable population. Our grain price index is preferable to the food price indices from national statistical agencies used in FAO (2013), Cachia (2014), and Ianchovichina et al. (2012) because the latter often contain processed and luxury food items that are of little relevance to the poor. As for these products, material costs play a minor role; therefore, using official food price indices would likely result in an underestimation of the degree of price transmission to the costs of the food basket of poor people. On the contrary, using individual crop prices instead of price indices – as in most existing studies – inflates the reported results of the empirical analysis, neglects possible substitution effects between grains, and complicates the interpretation of the severity of price transmission.

The market integration of developing countries is a highly relevant topic for policymakers and international organizations. Market integration presents both opportunities and risks. The larger a market is, the better its capability to diversify

[1] Cachia (2014) provides a more detailed overview on methods and data on regional price transmission.

(uncorrelated) shocks; this generally has a stabilizing effect on prices, benefitting producers as well as consumers. In contrast, integration into global markets makes domestic markets vulnerable to "external" shocks that are beyond the control of the national government, in particular, international price volatility (Kornher and Kalkuhl 2013). Market liberalization may further be incompatible with domestic price stabilization schemes, such as buffer stocks.

In this paper, we do not attempt to assess the costs and benefits of market integration. Leaving the normative debate aside, we address the descriptive question of the extent of market integration, which forms the basis of not only further normative analyses but also an appropriate impact assessment of global price shocks. Mapping price transmission with vulnerable population is one important step toward a better understanding of the impacts of recent global food price spikes since 2007. Additionally, our mapping analysis helps to identify the crucial international reference prices that should be monitored carefully in early warning and food security information systems. Finally, the calculated transmission elasticities can be used for forecasting the partial effect of international commodity price dynamics on local food prices and thus food security.

The paper is structured as follows: Section 12.2 provides an overview on existing literature on price transmission and market integration. Section 12.3 establishes the theoretical framework by drawing on basic trade and storage models from the literature. This section in particular helps to explain price transmission when trade is (temporarily) absent.[2] Section 12.4 describes the empirical model to estimate price transmission. Section 12.5 presents the price data used and the calculation of a domestic grain price index as an alternative reference price for the costs of the food basket of the poor. Section 12.6 discusses the results of the transmission analysis, including some robustness checks for different specifications. Section 12.7 summarizes the findings and concludes the chapter with policy and research implications.

12.2 Existing Work on Price Transmission

In the wake of the large swings in international commodity prices, there have been various researches on market integration and price transmission. Using staple prices on several sub-Saharan African markets, Minot (2010) calculated that the price increase in the region was on average 71 % of the corresponding world market increase in 2007/2008. Because static correlations between prices might be spurious and no compelling evidence for market integration exists (Ravallion

[2] Götz et al. (2013) provided an analysis on the price transmission of Ukraine and Russia during different trade regimes. The authors find that price transmission was also present during times of tight export quotas and high export taxes but stronger during liberal trade regimes.

1986), Minot (2010) extended the correlation analysis by applying a vector error correction model (VECM). This model, however, suggests that only one-fifth of the considered domestic price series have a long-run relationship to international prices. The estimated price elasticities range from 16 to 97 %. In general, rice prices seem to be more integrated than maize prices.

Robles (2011) estimated price transmission with an autoregressive distributed lag (ADL) model for some Latin American and three Asian countries using retail prices (Latin America) and wholesale prices (Asia) between 2000 and 2008. Transmission to processed food items is reported to be lower than to raw commodities. The average transmission from international wheat to domestic bread and pasta prices is 20 % and 24 %, respectively. In contrast, transmission of rice and wheat prices in Asia to the raw commodity prices varies a lot among the considered cities, but values higher than 50 % are reported for several cities.

Using a similar econometric approach but considering food price indices instead of commodity prices, Ianchovichina et al. (2012) analyzed price transmission to Middle East and North Africa countries. They report transmission for several countries in the range of 20–40 %. Greb et al. (2012) attempted to investigate price transmission and made some observations about the extent and determinants of market integration by assessing existing literature and by an own analysis based on FAO GIEWS price data. In their meta-analysis, they found that rice markets are more integrated than maize markets. They reported substantial price transmission to domestic markets (long-run price transmission coefficient of 75 %).

Most recently, Baquedano and Liefert (2014) calculated short- and long-run transmission coefficients for several commodities in developing countries within a single-equation error correction model (SEECM). They found that most consumer markets in developing countries are co-integrated with world markets although their speed of equilibrium adjustment is rather low. Cachia (2014) provided an overview of different concepts and models of price transmission and estimated market integrations and price transmission between the FAO (global) food price index and regionally aggregated food price indices (based on consumer price indices from national statistical agencies). His findings suggest limited market integration and rather slow transmission, which might be related to the use of aggregated food price indices as discussed above.

12.3 Theoretical Framework

Domestic prices are linked to world market prices primarily through trade. If a commodity is imported, its domestic price p_t^{D} equals its international price p_t^{G} plus the transaction costs $\tau_t^{I,E}$ for import I and export E. Depending on the trade balance (a positive T_t denotes exports, a negative T_t imports), we can therefore distinguish the three cases (Samuelson 1952)[3]:

$$p_t^{\mathrm{D}} = p_t^{\mathrm{G}} + \tau_t^I \quad \text{if } T_t < 0 \tag{12.1a}$$

$$p_t^{\mathrm{D}} = p_t^{\mathrm{G}} - \tau_t^E \quad \text{if } T_t > 0 \tag{12.1b}$$

$$p_t^{\mathrm{D}} = D\left(Q_t^{\mathrm{D}}, Y_t^{\mathrm{D}}\right) \quad \text{if } T_t = 0, \tag{12.1c}$$

where $D\left(Q_t^{\mathrm{D}}, Y_t^{\mathrm{D}}\right)$ is the inverse of the domestic demand function, which depends on consumption Q_t^{D} and income Y_t^{D}. Equations (12.1a)–(12.1c) imply that the domestic price is independent from the global price if and only if it is neither profitable to export nor to import the commodity, that is if

$$p_t^{\mathrm{G}} - \tau_t^E < D\left(Q_t^{\mathrm{D}}, Y_t^{\mathrm{D}}\right) < p_t^{\mathrm{G}} + \tau_t^I \tag{12.2}$$

Spatial arbitrage through trade links domestic and global prices immediately. There exists, however, also another form of arbitrage through storage which links current prices to expected (future) prices. Assuming rational expectations, current prices are a function of expected futures prices (Wright and Williams 1991):

$$p_t = \beta E_t\left[p_{t+1}\right] \quad \text{if } I_t > 0, \tag{12.3a}$$

$$p_t > \beta E_t\left[p_{t+1}\right] \quad \text{if } I_t = 0, \tag{12.3b}$$

where p_t is the price of the commodity at time t; $\beta = (1-\delta)/(1+r)$ contains the interest rate r and rate of deterioration δ; $E_t[\cdot]$ refers to the expectation at time t; and I_t denotes the inventory of grains. When there are no inventories ($I_t = 0$), current and future prices are not directly linked through intertemporal arbitrage.

Consider now the case of a country which has a zero or negative trade balance (that may change over time) but which is never in an exporting state. Combining Eqs. (12.1a) and (12.3a) for the domestic and global markets and assuming positive storage on both, for exactly s consecutive periods without trade, we obtain:

$$p_t^{\mathrm{D}} = \gamma^s p_t^{\mathrm{G}} + \left[\beta^{\mathrm{D}}\right]^s E\left[\tau_{t+s}\right] \quad \text{if } I_{t+j}^{\mathrm{D,G}} > 0,\ T_{t+j} = 0 \text{ for } 0 < j < s, \tag{12.4}$$

where $\gamma := \frac{\beta^{\mathrm{D}}}{\beta^{\mathrm{G}}} = \frac{\left(1-\delta^{\mathrm{D}}\right)\left(1+r^{\mathrm{G}}\right)}{\left(1-\delta^{\mathrm{G}}\right)\left(1+r^{\mathrm{D}}\right)}$. Equation (12.4) indicates that domestic prices depend on global prices even when there is *no trade* in a sequence of s periods. If

[3]In the subsequent theoretical analysis, we will assume that all transaction costs are unit costs and independent of the price level p_t^{G}. Considering ad-valorem transaction costs ς_t^I (e.g., due to transport insurance, value-added tax, or ad-valorem tariffs), Eq. (12.1a) would change to $p_t^{\mathrm{D}} = p_t^{\mathrm{G}}\left(1+\varsigma_t^I\right) + \tau_t^I$. As the ad-valorem component has no impact on the transmission elasticity (it cancels out after taking the derivatives), we have omitted it to shorten the formal analysis.

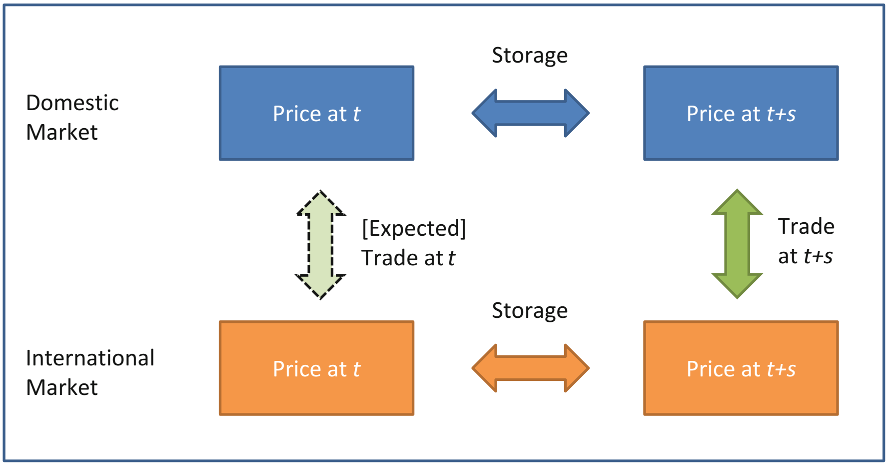


Fig. 12.1 Linkage between domestic and international prices through storage, trade, and expectations. *Source*: Own elaboration, based on Eqs. (12.1)–(12.4)

trade is expected in future periods (which brings domestic and global prices back to equilibrium), current domestic prices are adjusted according to intertemporal arbitrage. The relation between domestic and international markets for the direct trade regime and the indirect transmission regime (expected trade, with storage) is depicted in Fig. 12.1.

In the case of trade, prices at t are directly linked. In the case of no trade at t but expected trade at $t+s$, prices at t are indirectly linked through storage and expected trade arbitrage.

Inserting Eq. (12.4) into the transmission elasticity $\eta := \frac{\partial p^{\mathrm{D}}}{\partial p^{\mathrm{G}}} \frac{p^{\mathrm{G}}}{p^{\mathrm{D}}}$, we get[4]:

$$\eta = \frac{p_t^{\mathrm{G}}}{p_t^{\mathrm{G}} + [\beta^{\mathrm{G}}]^s E[\tau_{t+s}]}$$

Building partial derivatives of η, we obtain $\eta'\left(p_t^{\mathrm{G}}\right) > 0$, $\eta'\left(\beta^{\mathrm{G}}\right) < 0$, $\eta'\left(E[\tau_{t+s}]\right) < 0$, and $\eta'(s) > 0$. Thus, transmission increases in the global price level, and it decreases in the storage discount factor β^G and in expected transaction costs $E[\tau_{t+s}]$. Transmission increases, however, in the distance s to the next trade period: the longer the period of no trade, the stronger domestic prices respond to global prices (if storage domestic and global stocks are strictly positive during that period).

Table 12.1 gives an overview of the different possible trade and storage regimes and how they determine domestic prices and price transmission. In the case of trade,

[4]For $s = 0$, the transmission elasticity collapses to the standard form (direct transmission in case of trade) $\eta = p_t^{\mathrm{G}} / \left(p_t^{\mathrm{G}} + \tau_t\right)$. As argued above, any ad-valorem transaction costs cancel out in the price transmission.

Table 12.1 Domestic prices and price transmission for different trade and storage regimes

Trade T_t	Domestic storage	Global storage	Domestic price p_t^{D}	Transmission elasticity η
Yes	Yes/no	Yes/no	$p_t^{\mathrm{G}} + \tau_t$	$\frac{p_t^{\mathrm{G}}}{p_t^{\mathrm{G}} + \tau_t}$
None, but expected	Yes	Yes	$\gamma^s p_t^{\mathrm{G}} + \left[\beta^{\mathrm{D}}\right]^s E\left[\tau_{t+s}\right]$	$\frac{p_t^{\mathrm{G}}}{p_t^{\mathrm{G}} + \left[\beta^{\mathrm{G}}\right]^s E\left[\tau_{t+s}\right]}$
None, but expected	Yes	No	$\left[\beta^{\mathrm{D}}\right]^s E_t\left[p_{t+s}^{\mathrm{G}} + \tau_{t+s}\right]$	For p_t^{G} : 0 For $E_t\left[p_{t+s}^{\mathrm{G}}\right]$ $\frac{E_t\left[p_{t+s}^{\mathrm{G}}\right]}{E_t\left[p_{t+s}^{\mathrm{G}} + \tau_{t+s}\right]}$
None, but expected	No	Yes/no	$D\left(Q_t^{\mathrm{D}}, Y_t^{\mathrm{D}}\right)$	0
None and not expected	Yes	Yes/no	$\beta^s E_t\left[D\left(Q_{t+s}^{\mathrm{D}}, Y_{t+s}^{\mathrm{D}}\right)\right]$	0
None and not expected	No	Yes/no	$D\left(Q_t^{\mathrm{D}}, Y_t^{\mathrm{D}}\right)$	0

Source: Own elaboration

or in case of expected (future) trade, and positive domestic and global stocks, there is always a positive price transmission from global to domestic markets. However, if global stocks are zero[5] (i.e., if global prices are not in an intertemporal equilibrium), current global prices do not affect current domestic prices. Nevertheless, current domestic prices are in equilibrium with the *expected* global prices (which might, in turn, be a function of current global prices). Only in the remaining cases whereby all stocks are zero or whereby there will never be trade, domestic prices are completely decoupled from global prices. In these cases, domestic prices are solely determined by the conditions of domestic supply and demand, and price transmission is zero.

The theoretical analysis revealed two further interesting insights: For each trade regime, the transmission elasticity η is not affected by ad-valorem transaction costs (which include ad-valorem taxes and tariffs), and it is furthermore independent of the traded amount. In other words, the transmission elasticity will be the same for a country with small and large imports as long as the (unit) transaction costs are the same. Finally, the formal analysis emphasizes the role of storage in price transmission. Traditionally, storage is seen as a buffer against supply shocks, and this buffer reduces price fluctuations. As (private) storage, however, links current and future prices via expectations, it links domestic prices to global prices even if no trade occurs. Hence, storage could make a country more vulnerable against international price shocks because domestic prices are additionally linked to international prices through expectations.

While trade and storage link domestic prices to international prices of the same commodity, substitution effects might also link non-traded commodities to international prices if they are substitutes for traded commodities. The magnitude of substitution effects is expressed in the cross-price elasticity of demand, relating the percentage change in a commodity price to the percentage change in the price of a substitute. Hence, we would also expect price transmission to non-traded local products if they are substitutes for traded commodities. This is in particular the case for staples or different edible oils.

12.4 Empirical Model

As we are interested in the transmission of global shocks to domestic prices, any empirical analysis should consider intra-annual prices. However, many of the variables that determine price transmission (like grain stocks and trade) are only observable on an annual basis and suffer additionally from substantial measurement

[5] Zero stocks refer here to the theoretical model. In real-world settings, stocks become rarely zero because a certain amount of grains will be always stored for operational purposes. This “operational stock,” however, is not part of the intertemporal arbitrage dynamics as it is used to ensure deliveries and does not respond to (expected) prices.

errors and data quality problems.[6] While there are models that allow data of different frequencies to be combined [e.g., GARCH-MIDAS for analyzing volatility, see Engle et al. (2013)], estimating them requires typically a large sample size. Because most of our price series start after the year 2000, we used a pure time-series approach to quantify country- and crop-specific "average" transmission elasticities instead of estimating the underlying fundamental model parameters, like the transaction costs, trade flows, and storage levels.

Time-series models are often confronted with the problem of nonstationary data series, which generates biased estimates and high R^2 due to spurious regression of explanatory variables with trends which leads to the overestimation of t-values in the case of autocorrelation. The typical approach to deal with a nonstationary time series is to differentiate the data until it becomes stationary. If the time series is also co-integrated (i.e., there exists a linear combination of the series that is integrated of order one), it is possible to estimate the long-run relationship between trended variables within an error correction model (ECM) (Engle and Granger 1987). If the time series is integrated to the order of one but not co-integrated, one can analyze the first-differenced, stationary time series within an autoregressive distributive lag model (ADL). If the time series is stationary, the ECM can be made equivalent to an ADL (De Boef and Keele 2008).

An ECM would be the favorable model to test for market integration (i.e., co-integration of domestic and international price series). However, the transmission of short-term shocks in international prices to domestic prices, which is the focus of this paper, does not require co-integrated time series. Relying on co-integrated time series only could exclude countries with significant transmission of shocks.[7] Using an ADL for this set of countries would be one option. As the estimated short-run transmission elasticities of the ADL are not directly comparable to the ECM, which controls for error correction, we prefer to use the same econometric model for all countries and series. Hence, we used an ADL with stationary first-differenced logarithmic prices, which is suitable for all countries and price series.[8] Our basic model estimates the relative change of the domestic food price index as follows:

$$\Delta p_{it}^{\mathrm{d}} = \sum\nolimits_{j=1}^{l} \alpha_i^{dw} \Delta p_{it-j}^{d} + \sum\nolimits_{j=1}^{k} \beta_{ij}^{dw} \Delta p_{t-j}^{w} + \sum\nolimits_{j=1}^{k} \gamma_{ij}^{dw} \Delta e_{it-j} + \sum\nolimits_{j=1}^{k} \zeta_{ij}^{dw} \Delta p_{t-j}^{\mathrm{oil}} + \delta_{im}^{dw} + c_i^{dw} + \varepsilon_{i,t}^{dw}, \tag{12.5}$$

[6]Stocks data is, for example, lacking for many countries. Published stock data (e.g. on the USDA-PSD database) is for many developing countries based on rough estimates and balance sheet calculations rather than original survey data.

[7]Additionally, testing for a unit root process, a necessary condition for the ECM, is problematic due to the low performance of unit root tests. Hence, the use of the ADL avoids the risk of using a misspecified ECM.

[8]The stationarity of all domestic and international price series was tested using the Augmented Dickey-Fuller test. While only a few of the original series are stationary, all first-differenced series are stationary with a test statistic below the 1 % critical value. Results are available upon request.

where $\Delta x_t = x_t - x_{t-1}$ is the difference operator, $p_{i,t}^d$ denotes the domestic reference price d (or price index) in country i (all prices in logs) at time t, p_{t-j}^w is a world market reference price (or price index), $e_{i,t-j}$ the exchange rate (in US dollars) of country i, p_t^{oil} is the oil price, $\delta_{i,m}$ a monthly country-specific dummy to account for seasonality, and c_i^{dw} is a (country and commodity specific) constant. We chose the lag structure $l = 3$ and $k = 3$ in our base model, but we also explored different lag structures (including optimal lags using information criteria) as a robustness check. Although oil prices are neglected in most other studies, we considered them important as they influence domestic production and transportation costs as well as import costs (Minot 2010).

Controlling for seasonality (Helmberger and Chavas 1996) and oil prices may allow us to consider important determinants of food and grain prices in particular countries; it might, however, also weaken the reliability of the model due to decreased degrees of freedom for countries in which seasonality or oil prices are irrelevant. Therefore, to automatically select the appropriate model specification for each country and commodity, we applied the Akaike information criterion to (1) the full model, (2) a model which ignores oil prices, (3) a model which ignores seasonality, and (4) a model which ignores both oil prices and seasonality.

We ran the regression in Eq. (12.5) separately for each country i, each international reference price p_t^w and each considered domestic food price p_t^d. With the estimated coefficients, we calculated the short-run transmission $\beta_i^{dw} = \sum_{j=1}^k \beta_{ij}^{dw}$ and the pass-through θ (i.e., the equilibrium effect of a marginal world price change on the domestic food price index) of international price w to domestic price d in country i as:

$$\theta_i^{dw} = \frac{\sum_{j=1}^k \beta_{ij}^{dw}}{1 - \sum_{j=1}^l \alpha_{ij}^{dw}},$$

where $\beta_i^{dw} = \sum_{j=1}^k \beta_{ij}^{dw}$ and $\alpha_i^{dw} = \sum_{j=1}^l \alpha_{ij}^{dw}$; both terms are set to zero if they are not significant at the 5 % level (F-test with Newey-West estimated standard errors).[9] While β_i^{dw} gives the direct (short-term) price transmission within 1–3 months, the autoregressive term α_i^{dw} further amplifies price changes in the subsequent periods. The total effect is therefore given by the pass-through θ_i^{dw}. As we estimated β_i^{dw} and θ_i^{dw} separately for each country and international commodity price (index), we obtained a matrix of transmission elasticities and pass-throughs for every domestic food price index d.

[9]Significance levels of 10 % and 1 % were also employed to check robustness (see below). The Newey-West estimator corrects for heteroskedasticity and autocorrelation. We use a lag length of 6 months. The standard OLS procedure gives similar results (see below).

12.5 Data

This study differs from other related studies because it used an extensive dataset of international commodity prices and price indices, ranging from spot prices at important export destinations to prices of relevant futures contracts.

Table 12.3 in the Appendix lists the prices that were used as international reference prices and price indices. The main sources of information are the FAO and the FAO GIEWS for the international food prices and price indices, the World Bank (2013b) for important international spot prices, and Bloomberg for futures prices. We also calculated indices over futures prices in order to better capture price dynamics on commodity exchanges. For all futures prices, a time series consisting of the respective active contract was used. All price series are monthly data (for daily price series, like futures prices, monthly averages were calculated).

The food price indices (FPI), a part of the national consumer price indices (CPI), served as reference database for the domestic prices. These data are available from the LABORSTA database for 200 countries in the world in a monthly or quarterly frequency (ILO 2013). We drop those countries which only report quarterly food price indices and consider the years 2000–2012.[10] While the LABORSTA database has the advantage of covering many countries, the calculation of the food price indices is not transparent for many countries. In particular, CPIs may suffer from urban bias as price collection in urban area is less expensive than in remote rural areas. Additionally, the weights in a CPI might reflect the consumption and spending patterns of the urban lower-middle class rather than the very poor households that spent up to 70 % of their expenditures on staple food (James 2008). For example, dramatic changes in staple prices, which affect the real income of poor households, might only lead to small changes in the domestic food price index, which consists of processed foods as well as luxury food and beverages.

Because FPI data might be inadequate to monitor the food costs for poor people, we developed an alternative staple grain price index which consists of the retail prices of wheat, maize, rice, sorghum, and millet. We used several sources to compile this retail price database and calculate the national average price in US$ across different markets for each of the commodity prices. We used prices in US$ to avoid the problem of strong inflationary shocks, which are difficult to control for, but provided robustness checks for prices in nominal and CPI-deflated local currencies. We combined the different commodity prices into a price index according to their share of the domestic per capita food supply [taken from FAOSTAT (2013)]:

$$p_{it}^{GPI} = \sum_{j} \alpha_{ij} p_{itj},$$

[10]These countries are (20 in total) AIA, ASM, AUS, BLZ, BTN, COK, CYM, FRO, GUM, JEY, KIR, MHL, MNP, NFK, NIU, PNG, SHN, SPM, TUV, and VUT.

Table 12.2 Domestic food price indices

d	Variable	Description	Source
FPI	Food price index (FPI)	National food price index (nominal); 2000–2012	ILO (2013)
GPI	Domestic grain price index (GPI)	Index of the national average retail prices (nominal US$) of five staple grains for 2000–2012: wheat, maize, rice, sorghum, and millet; weighted according to domestic per capita food supply for 2000–2009	Own calculation; domestic per capita food supply from FAO; retail prices from FEWS NET, FAO GIEWS, WFP Price Monitor, and national sources

Exchange rates were obtained from the IMF database. For the oil price, we consider the "average oil price" of WTI, Brent and Dubai prices quoted at World Bank Commodities Price Database.
Source: Own elaboration

where $\alpha_{ij} = C_{ij}/C_j$ is the j-th crop's share of the total consumption of the considered grains in country i in kg over the period 2000–2009 and p_{itj} is the corresponding crop price at month t in US$ per kg. We used national average prices if available in one of the databases (shown in Table 12.2); otherwise, we calculated an (unweighted) national average price using all the markets price data available (again, using the sources shown in Table 12.2). Our self-constructed grain price index accounts on average for 45 % of the average national calorie consumption in many countries. As the diet of poor people consists of a higher share of staples, our grain price index is likely to cover more than the national average number for poor people which increases its relevancy.

One drawback of the grain price index is the limited data availability. Contrary to the food price index from national statistical offices, retail grain prices were available for 65 countries only. Yet, as will be discussed later, the considered countries are home to more than 90 % of the global poor, who live with an income below $1.25 per day. Thus, the coverage with respect to poor people is much larger than the "geographical" coverage. Another drawback of the grain price index is that it is likely irrelevant to the countries where staples other than those grains considered in this study are consumed as part of their diet (e.g., roots and tubers in Uganda). Because of the advantages and disadvantages of both food price indices and grain price indices, we considered both in our analysis. Table 12.2 summarizes the characteristics and data sources for the domestic price indices.

12.6 Results

This section presents and discusses the calculated transmission elasticities. For policymakers as well as for establishing early warning information systems, it might be relevant to know whether a country's food prices are linked to at least one international commodity price. Subsequently, a country's policymakers can access the database on transmission elasticities to find out which particular commodity prices are transmitted from the international market to the domestic market of that particular country. We therefore calculated a country-specific transmission *vulnerability indicator* V_i^d as the maximum transmission over the pass-throughs of different commodities from the set Ω:

$$V_i^d = \max_{w \in \Omega} \{\theta_i^{dw}\} \tag{12.5}$$

If this indicator is zero, domestic food markets are with a high degree of certainty not vulnerable to global price shocks.[11] If the indicator is high, there is high transmission for at least one international commodity price (or price index), which implies that the country is generally vulnerable to global market price changes. As we will see, the vulnerability indicator provides an important benchmark for single international prices or price indices, like the FAO food price index. We further calculated the vulnerability indicator for subsets Ω of commodities, for example, we calculated V_i^d as maximum pass-through overall international rice prices.

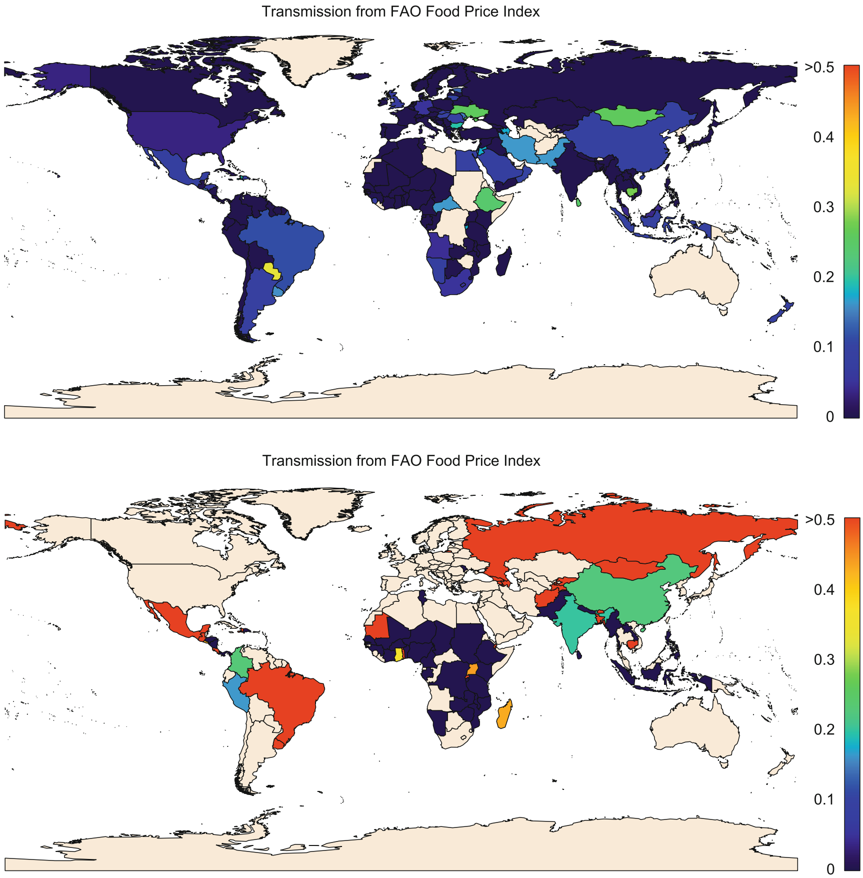
12.6.1 Transmission from the FAO Food Price Index

We first considered the transmission from the FAO food price index – an international reference price index – which is often used as an indicator for global food market dynamics. We ran regressions for the transmission to domestic food prices as well as to domestic grain prices. The magnitude of the aggregate transmission elasticity β (if significant at the 5 % level) is depicted in Fig. 12.2 for both the domestic food price index (Fig. 12.2a) and the domestic grain price index (Fig. 12.2b). The maps indicate that there was no significant transmission for several developing countries in Asia, Latin America, and Africa. Where there was statistically significant transmission, it tended to be particularly high. These findings are consistent with the other studies mentioned above but provide a more comprehensive country coverage.

The map showing global transmission to domestic food price indices, for which data is available for almost all countries in the world, reveals another interesting finding: Several developed countries (North America, Europe) show a statistically significant but low price transmission, while transmission to developing countries is either insignificant (i.e., zero) or relatively high. An explanation for this finding is that the food basket in developed countries consists of many processed food items; commodity costs constitute only a very small share of the final price of process food items. Thus, a price increase in a raw commodity translates only into a very small price increase in the final product. This explains why price transmission to the US domestic market is very low – although several of the international reference prices used are quoted from US markets. The transmission from world to domestic

[11]However, they might still be co-integrated with world markets (through rather slow adjustment process) as we do not test for co-integration.

a



b

Fig. 12.2 (**a**) Transmission from the FAO food price index to the domestic food price index (FPI). (**b**) Transmission from the FAO food price index to the domestic grain price index (GPI)

markets showed high variance among developing countries because some of them are not integrated into the world market due to high transaction costs. If a country is integrated, price transmission to its domestic market is relatively high because raw commodity costs are a major part of the price of many food items.

The FAO food price index is a much more aggregated price index. It uses weights according to the export share on the global market of the considered commodities. While this gives an appropriate average price index for globally traded commodities, trade patterns may differ greatly among countries. For example, a country might predominantly import rice, but rice prices have a very low weight in the FAO food price index. By adding further international price indices and concentrating on the vulnerability indicator (maximum transmission) for all the grain prices in our database, we got a map which reveals a different result. Many Asian, African, and Latin American countries experience significant and high price transmission

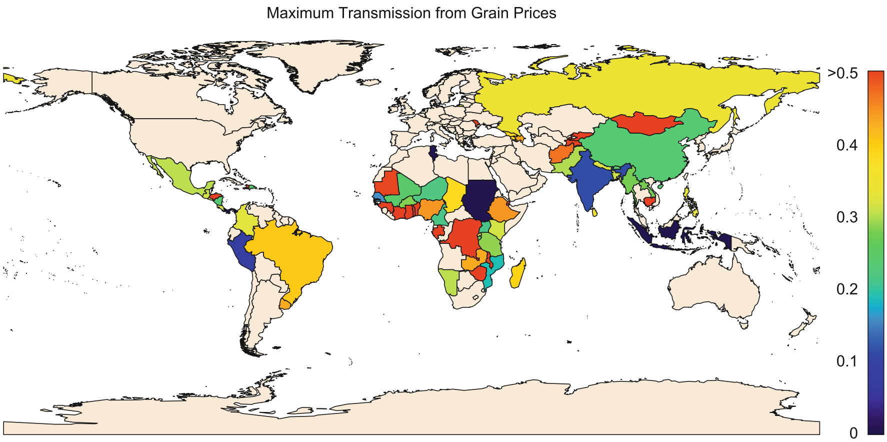


Fig. 12.3 Transmission to the domestic grain price index – vulnerability indicator over international grain prices. *Note*: Maximum transmission to the domestic grain price index using all international grain prices in Table 12.3

(Fig. 12.3). For example, some of the West African countries showed high price transmission to their domestic grain price index, which is primarily driven by international rice prices as these countries import a large amount of rice. Note that a low transmission elasticity of even as low as 20 % may have remarkable implications: doubling of commodity prices (e.g., as was experienced for wheat in 2007/2008) increases the costs of the *entire food or staple commodity basket* by 20 %. This is an important difference when compared with other studies: transmission elasticities for a single commodity do not reveal how important the commodity is for the population. Using a price index, in contrast, weights the price transmission in relation to the importance of the commodity to the diet of a country's population, and it also takes into account any potential substitution effects.

The use of the vulnerability indicator emphasizes that considering the FAO food price index exclusively might lead to serious biases in the assessment of price transmission downward. Thus, it is important to consider a larger set of reference prices and price indices rather than only relying on the FAO food price index. However, the FAO food price index remains a pragmatic alternative when only a single international price (index) can be used.

12.6.2 Vulnerability Mapping: How Many Poor People Are Affected by Global Price Changes?

To assess the impacts of global price changes, it is important to know how many poor people live in countries with high price transmission. Price changes have often heterogeneous impacts on the welfare of households, depending on their production structure and market access (von Braun et al. 2013). High agricultural commodity prices can increase the income of poor rural households who produce cash crops (Tefera et al. 2013). Nevertheless, such beneficial impacts are often realized in the medium or long term when households adjust their production by growing high-value crops. However, existing empirical analyses have concluded that sudden price spikes negatively affect not only poor consumers and the landless but also farmers who buy many food items as they cannot quickly adjust their production in the short run (Aksoy and Isik-Dikmelik 2008; Anríquez et al. 2013).

To assess how strongly poor people are exposed to global price changes, we took the following steps: The transmission elasticities β of the countries (e.g., regarding the Chicago corn price or the vulnerability indicator containing the maximum transmission by grain prices) were sorted in descending order. Next we calculated the number of people living below the extreme poverty line of \$1.25 per day[12] using poverty share and population data from the World Development Indicators (World Bank 2013a).[13]

Figure 12.4 shows the transmission from different international grain prices to the domestic grain price index. We calculated the maximum transmission (vulnerability indicator) according to Eq. (12.1b) for each of the three commodities: wheat, corn, and rice. Hence, the wheat line shows the maximum transmission for each country from all the available wheat price series shown in Table 12.3. We calculated the total vulnerability indicator as the maximum over the commodity indicators (blue line).

Regarding the extent of transmission, Fig. 12.4 clearly shows that rice prices are most strongly transmitted; this has also been highlighted by other studies (e.g., Robles 2011; Baquedano and Liefert 2014). While wheat prices experience lower transmission elasticities than rice prices for many countries, the tail is much longer due to its impact on India, where one-third of the globally poor live. The all-grain vulnerability indicator revealed that more than 1.06 billion poor people live in countries with significant price transmission of 10 % or higher – which constitute 96 % of the poor in the countries studied in this chapter and 89 % of the poor globally. More than 360 million poor people (one-third of the poor) live in countries with transmission elasticities of 30 % or higher; about 44 million poor people live in countries with transmission elasticities of 50 % or higher.

We decomposed the transmission further into the individual price series (see Appendix, Figs. 12.8, 12.9, 12.10, 12.11 and 12.12) to identify the most relevant international reference price for each of the commodities. Prices of futures contracts at the Chicago Board of Trade (CBOT) are the most relevant for wheat, in particular regarding the number of people affected. Transmission elasticities from CBOT prices are, however, topped by transmission rates from Canadian wheat and Argentinian spot prices for some countries (e.g., Nigeria, Ethiopia, or Kenya). For maize, US spot and futures prices were transmitted at rates ranging from 15 to

[12]Using the “moderate poverty line” of \$2 per day gives qualitatively similar results. Quantitatively, however, roughly double as many people are affected.

[13]Poverty rates are not available for every year. We use therefore the most recent number and multiplied it with the 2012 number of total population.

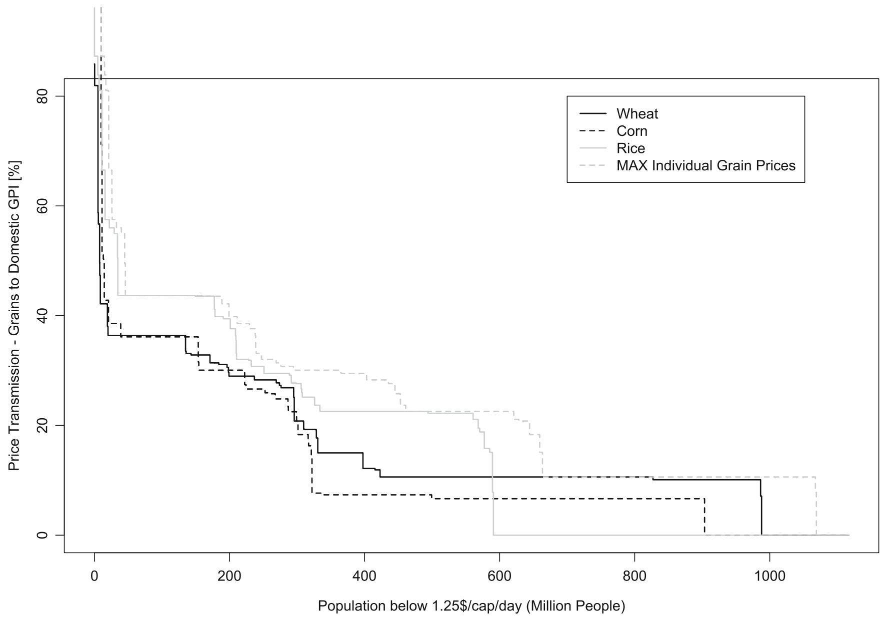


Fig. 12.4 Number and extent of poor people potentially affected by international price changes (change of grain price index). *Note*: The figure shows the transmission elasticities over all countries in descending order mapped to the number of people below the extreme poverty line in the particular country. *Source*: Own illustration

50 % for 150 million poor people. Yellow and white maize prices at the South African Futures Exchange (SAFEX) are strongly transmitted to Malawi at rates higher than 70 %. There is no clear reference price emerging for rice. IGC rice prices and Pakistani and Thai prices transmit at different rates to different countries, with Nigeria experiencing high transmission, in particular from Thai prices and the IGC price index.

Comparing the transmission indicated by the all-grain vulnerability indicator with several other price indices emphasizes that using individual price index alone would cause the size of the affected population to be underestimated. For example, the FAO food price index, a popular international reference price, suggests that 700 million poor could be affected by global price shocks (due to its significant transmission to India and China); the FAO cereals price suggests that 350 million people could be affected – far below the numbers obtained from the all-grain vulnerability indicator. The FAO food price index shows a higher transmission elasticity than most indices that are based only on grain prices because the FAO food price index has a lower variability.[14]

[14]The FAO food price index also contains meat and oils, which are processed food items that typically fluctuate less than commodity prices. Comparing the FAO food price and cereals price

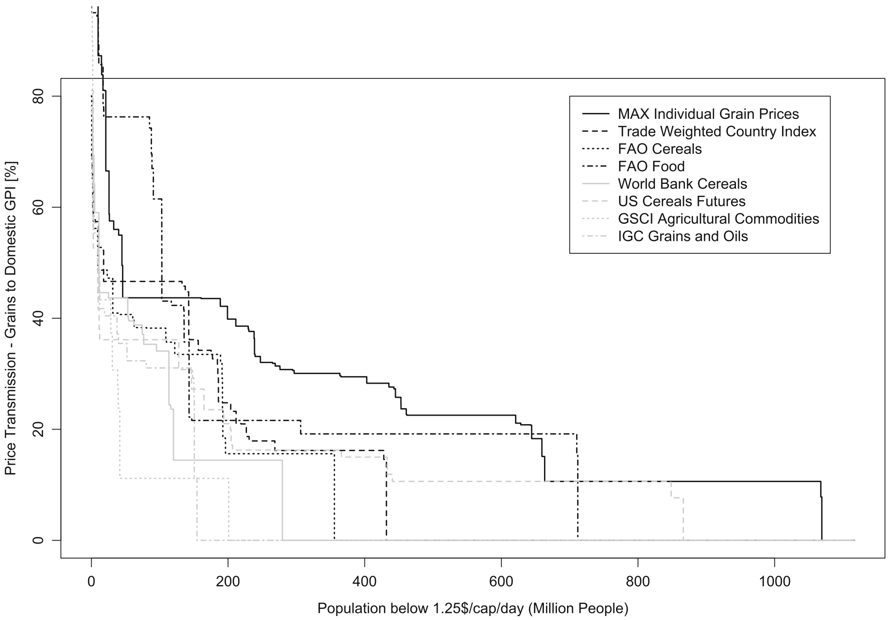


Fig. 12.5 Number and extent of poor people potentially affected by changes of international price indices. *Source*: Own illustration

Figure 12.5 further illustrates that about 850 million poor people might be affected by price changes in US cereals futures contracts (140 million with transmission rates of 30 % or higher), which is particularly relevant for the debate on speculation and financialization (Tadesse et al. 2014; von Braun et al. 2013). The transmission elasticities from commodity prices and price indices for countries with at least one million people living below the poverty line are listed in Table 12.4 in the Appendix.

The calculations shown in Figs. 12.4 and 12.5 require an important qualification: They represent the likely upper bound of the number of people affected. More precisely, they show the number of poor people living in countries affected by a specific price transmission. Not all poor people in a country with positive price transmission experience international price changes. In developing countries, in particular Africa, poor people in remote rural areas lack access to markets due to bad infrastructure (Barrett 2008; Nelson 2008). As discussed previously, food price indices from national statistical agencies could exhibit biases because of their focus on urban centers, making them less relevant for the rural population

index between 1990 and 2011, the former shows an average change rate of ±0.8 % per month, while the latter changes ±1.3 % per month. We would therefore expect a roughly 60 % higher transmission from FAO food prices for an identical commodity composition compared to cereals prices.

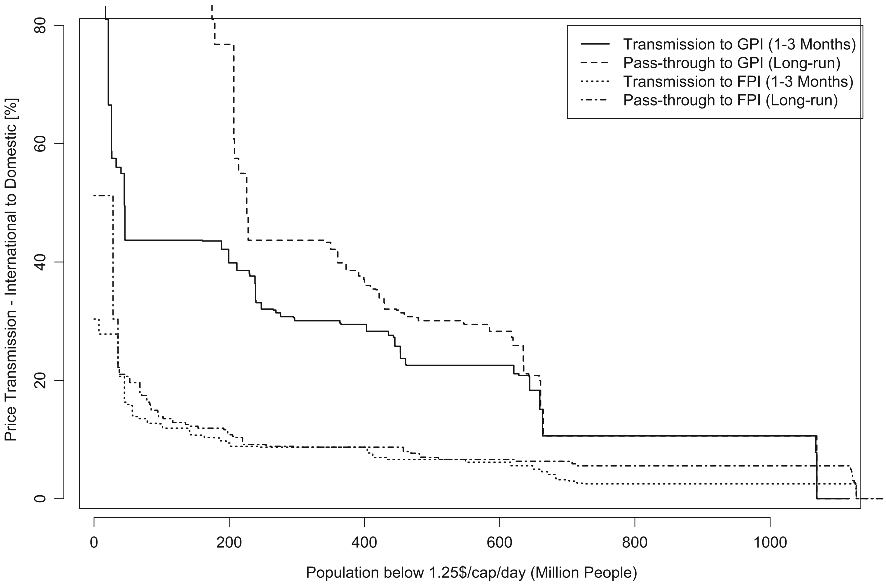


Fig. 12.6 Comparison of transmission and pass-through. *Source*: Own illustration

in remote areas. A transmission analysis based on food price indices from national statistical agencies would overstate the number of affected poor as one would expect lower price transmission from international prices to remote rural markets. The use of the grain price index which also considers grain prices from rural markets is an important alternative because it is constructed independent of the FPI using alternative price data. Nevertheless, the markets considered in this study are far from comprehensive, and prices for many rural areas are missing. The number of poor people in affected countries therefore only indicates the potential number of people affected (which would be the same if domestic markets were perfectly integrated).

12.6.3 Pass-Through and Equilibrium Effects

While the sum of the coefficients of international prices β gives the relative magnitude of price transmission 1–3 months after a spike, the pass-through θ considers long-run equilibrium adjustments due to the autoregressive term (see Sect. 12.4 above). Figure 12.6 depicts the vulnerability indicator (maximum overall international grain prices) for both transmission and pass-through to the domestic food price index as well as to the domestic grain price index. Consistent with Figs. 12.2 and 12.3, we found that transmission elasticities are considerably higher for the domestic grain price index than for the domestic food price index. The long-run equilibrium effect of international price spikes is substantially higher: For high vulnerable countries, the long-run effect is approximately twice as high as the short-run effect. The discrepancy between short-run transmission and long-run pass-though is higher when domestic grain prices instead of domestic food prices are considered. This is due to the more important role of the auto-regressive dynamics.

12.6.4 Robustness Checks

The outcome of our econometric analysis depends on not only the chosen model specification but also the considered significance levels. We therefore discuss the implications of different model specifications for our findings. We confine our discussion only to the vulnerability indicator for grain prices, in particular, with regard to its mapping to affected poor people (as shown in Fig. 12.4).

12.6.4.1 Significance Levels

If the null hypothesis of zero transmission cannot be rejected at the 5 % level, we set the transmission to zero; otherwise, we use the point estimate for the calculation of the transmission. Changing the significance level to 10 % increases the likelihood of erroneously detecting transmission to a country's domestic market when there is none; it reduces, however, the possibility of wrongly concluding that there is no price transmission in the case that the F-test does not reject the null hypothesis of zero transmission. We therefore employed two different significance levels (at 10 % and 1 %) to check the sensitivity of our results. As shown in the Appendix, a significance level of 10 % has only marginal impacts on the extent of price transmission and the number of poor people affected (Fig. 12.7). For a stricter significance level of 1 %, the transmission is lower relative to the poor population: Many countries on the right tail (with low transmission rates) do not pass the stricter significance test. Nevertheless, transmission elasticities for the 550 million poor people in countries with significant transmission hardly changed when compared with the lower significance levels.

12.6.4.2 CPI-Deflated Food Prices

It is often argued that nominal price changes are less relevant because monetary inflation might change the overall price level and therefore the purchasing power of money. To study welfare impacts of price changes, one would ideally deflate nominal prices with (nominal) income for consumers. This information is, however, hardly available.[15] Using the consumer price index (CPI) is a pragmatic alternative, although CPIs do not measure the income or wage of people but rather the costs of goods a consumer who is representative of the population buys. For some countries (e.g., Bangladesh), food items have a share over 50 % of the CPI (ILO 2013). Thus, even without any monetary inflation and without any increases in wages or prices of other consumption goods, an increase in food prices by 10 % would increase the CPI by more than 5 %. Deflating the food price change with the CPI would then

[15]For households with substantial income from selling their agricultural produce, prices of inputs need also to be considered (Dorward 2011).

result in a "real" price change of 5 %, although wages and other consumer prices would remain constant. Deflating the food price index with the CPI would in such cases understate the impact on welfare due to price changes.

Due to the lack of monthly wage or income data, we resorted to deflating food prices by the CPI despite knowing its shortcomings. As our grain price index used prices in the US dollar, which shows very low monthly inflation rates, we performed this robustness check only for the domestic food price analysis. As expected, the transmission to CPI-deflated food price indices was lower than to nominal food prices (Fig. 12.7). The transmission-population curves obtained are similar to our standard model, although slightly lower to the right tail (in particular, for India which experiences high inflation). Using nominal prices in the local currency also gave results similar to our standard model. The robustness of our findings regarding the choice of the currency and deflator is probably due to the use of first differences of log prices, which cancel out inflation, and the use of heteroskedasticity-corrected standard errors by the Newey-West method.

12.6.4.3 OLS Versus Newey-West

To check the robustness of the Newey-West approach with time lags of 6 months, we also included regressions based on the standard OLS, whereby homoskedasticity is assumed for calculating standard errors and thus significance levels. The OLS method allows for a much faster calculation of the standard errors; this becomes important when applying the method to many country and commodity time series. As indicated in Fig. 12.7, OLS gives similar results, although transmission rates were slightly lower as high transmission elasticities for some commodities did not pass the *t*-test at the 5 % level anymore.

12.7 Conclusions

The aim of this paper is to better understand the transmission of shocks from international prices to domestic food prices. Our analytical model emphasized that international price changes can be transmitted through intertemporal arbitrage of storage even if no trade takes place. Our empirical analysis suggests that focusing only on the FAO Food or Cereal Price Indices might cause the vulnerability of the poor to international price changes to be understated. Likewise, food price indices from national statistics might be biased, being more representative of (on average wealthier) urban consumers, who buy and consume relatively more processed staples and luxuries. To avoid these shortcomings, we used a comprehensive database on international reference prices and constructed a domestic grain price index based on retail prices in developing countries and the considered commodities' share of the total consumption. Our price database allows for almost universal country coverage, in particular, with respect to countries where poor people live. For the first time therefore, we were able to estimate how many poor people live in countries where international price changes are transmitted to domestic prices.

Our empirical analysis illustrated that the vast majority of the poor (over 90 %) live in countries where food prices are linked more or less strongly to international prices *in the short term* that is within 1–3 months. For 360 million poor people, international prices transmit to their country at rates of 30 % or higher. The empirical analysis considered seasonality and oil prices (endogenous model selection). The findings were robust at different significance levels and for different price deflators.

Because of our chosen lag structure of 3 months, we expect that international price shocks will translate to domestic price shocks rather quickly. Existing research on the impact of price changes on the welfare of poor consumers has paid more attention to the differentiated and heterogeneous effects of price changes, depending on the production and consumption structure. While higher prices can benefit net sellers of the affected crops, they make poor consumers, net buyer farmers and rural landless worse off in the short term. Several quantitative estimates concluded that the negative effects overweigh the positive effects, for example, with respect to the number of people falling below the poverty line – at least in the short term when production is not able to respond flexibly to higher prices (Ivanic and Martin 2008; Tiwari and Zaman 2010; de Hoyos and Medvedev 2011; Anríquez et al. 2013). There are also concerns that price increases affect poor consumers more than the effect of a symmetric price decrease on producers of food: While poor consumers can run into serious problems because they cannot afford sufficient food, producers may still have enough (self-grown) food to eat, even though their income may be significantly reduced (Kalkuhl et al. 2013).

Although our analysis focused on the transmission of price levels rather than price risk or volatility, one can expect that high international volatility (measured in the fluctuations of *monthly* prices) would also increase domestic food price volatility (see also Chap. 13). While the impacts of price changes on welfare are as yet unclear, higher volatility may have negative effects on welfare because of an increase in the production risks for farmers and, thus, undermining long-term food supply (Haile and Kalkuhl 2013; Haile et al. 2013).

The transmission analysis and the estimated elasticities could be used in early warning systems to detect vulnerable countries in times of high international price swings. It could further be extended to explain the different degrees of price transmission by using other explanatory variables like transportation costs, trade, GDP, or grains stocks.

Acknowledgments I would like to thank Felix Baquedano for his valuable comments and suggestions on the econometric model as well as the representation of the findings. I further thank Mekbib Haile, Manuel Hernandez, Lukas Kornher, and Miguel Robles for their useful comments on an earlier version of this paper. I am grateful to Mikko Bayer, David Schaefer, and Christian Zimpelmann for building and enhancing the database on international and domestic food and commodity prices; Tobias Heimann helped converting the figures to EPS format. We thank the FAO GIEWS team and FEWS NET for providing price data on commodities in developing countries. Financial support from the Federal Ministry for Economic Cooperation and Development (BMZ) is gratefully acknowledged.

Appendix

International Reference Prices and Price Indices

Table 12.3 Considered international reference prices and price indices

w	Variable	Description	Source
1	FAO food price index	Consists of 55 commodity quotations considered as representing the international prices of food commodities; weighted by export share	FAO
2	FAO cereals price index	Consists of wheat, maize, and rice prices; weighted by export share	FAO
3	FAO oil/fat price index	Consists of 12 different oils (including animal and fish oils); weighted by export share	FAO
4	FAO sugars price index	Index form of the International Sugar Agreement prices with 2002–2004 as base	FAO
5	FAO meat price index	Consists of poultry, bovine meat, pig meat, and ovine meat products; weighted by export share	FAO
6	FAO dairy price index	Consists of butter, skimmed milk powder, whole-milk powder, cheese, and casein prices; weighted by export share	FAO
7	WB grain price index	Includes barley, maize, rice, and wheat	World Bank
8	WB fats and oils price index	Includes coconut oil, groundnut oil, palm oil, soybeans, soybean oil, and soybean meal	World Bank
9	Wheat (HRW) US	No. 1, hard red winter, ordinary protein, export price delivered at the US Gulf port for prompt or 30 days' shipment	World Bank
10	Wheat (SRW) US	No. 2, soft red winter, export price delivered at the US Gulf port for prompt or 30 days' shipment	World Bank
11	Wheat CAN	Wheat (Canada), no. 1, western red spring (CWRS), in store, St. Lawrence, export price	World Bank
12	Wheat AUS	Australian soft white, Australia, f.o.b.	USDA/IGC
		Australia Eastern States Standard White Wheat FOB Spot (for 10/2007–09/2008 where USDA/IGC series has missing entries)	Bloomberg
13	Barley	Barley (Canada), feed, western no. 1, Winnipeg Commodity Exchange, spot, wholesale farmers' price	World Bank
14	Sorghum US	Sorghum (US), no. 2 milo yellow, f.o.b. Gulf ports	World Bank
15	Corn US	Maize (US), no. 2, yellow, f.o.b. US Gulf ports	World Bank
16	Soybeans	Soybeans (US), c.i.f. Rotterdam	World Bank
17	Soybean oil	Soybean oil (Any origin), crude, f.o.b. ex-mill Netherlands	World Bank
18	Soybean meal	Soybean meal (any origin), Argentine 45/46 % extraction, c.i.f. Rotterdam beginning 1990; previously US 44 %	World Bank

(continued)

Table 12.3 (continued)

w	Variable	Description	Source
19	Rice Thai A1	Rice (Thailand), 100 % broken, A.1 Super from 2006 onward, government standard, f.o.b. Bangkok; prior to 2006, A1 Special, a slightly lower grade than A1 Super	World Bank
20	Rice Thai 5 %	Rice (Thailand), 5 % broken, white rice (WR), milled, indicative price based on weekly surveys of export transactions, government standard, f.o.b. Bangkok	World Bank
21	Rice Thai 25 %	Rice (Thailand), 25 % broken, WR, milled indicative survey price, government standard, f.o.b. Bangkok	World Bank
22	Rice Vietnam	Vietnamese rice, 5 % broken	World Bank
23	Palm oil	Palm oil (Malaysia), 5 % bulk, c.i.f. N. W. Europe	World Bank
24	Groundnut oil	Groundnut oil (any origin), c.i.f. Rotterdam	World Bank
25	Coconut oil	Coconut oil (Philippines/Indonesia), bulk, c.i.f. Rotterdam	World Bank
26	Fishmeal	Fishmeal (any origin), 64–65 %, c&f Bremen, estimates based on wholesale price, beginning 2004; previously c&f Hamburg	World Bank
27	Beef	Meat, beef (Australia/New Zealand), chucks and cow forequarters, frozen boneless, 85 % chemical lean, c.i.f. US port (East Coast), ex-dock, beginning 11/2002; previously cow forequarters	World Bank
28	Chicken	Meat, chicken (US), broiler/fryer, whole birds, 2½–3 pounds, USDA grade “A,” ice-packed, Georgia Dock preliminary weighted average, wholesale	World Bank
29	Sheep	Meat, sheep (New Zealand), frozen whole carcasses prime medium (PM) wholesale, Smithfield, London, beginning 01/2006; previously Prime Light (PL)	World Bank
30	Wheat/CBT	#2 Soft red winter at contract price, #1 Soft red winter at a 3 cent premium, Chicago Board of Trade	Bloomberg
31	Corn/CBT	#2 yellow at contract price, #1 yellow at a 1.5 cent/bushel premium, #3 yellow at a 1.5 cent/bushel discount, Chicago Board of Trade	Bloomberg
32	Soybeans/CBT	#2 Yellow at contract price, #1 yellow at a 6 cent/bushel premium, #3 yellow at a 6 cent/bushel discount, Chicago Board of Trade	Bloomberg
33	Soybean oil/CBT	Crude soybean oil meeting exchange-approved grades and standards, Chicago Board of Trade	Bloomberg
34	Soybean meal/CBT	48 % protein soybean meal, Chicago Board of Trade	Bloomberg

(continued)

Table 12.3 (continued)

w	Variable	Description	Source
35	Rough rice/CBT	US no. 2 or better long grain rough rice with a total milling yield of not less than 65 % including head rice of not less than 48 %, Chicago Board of Trade	Bloomberg
36	Feeder cattle/CME	650–849 pound steers, medium-large #1 and medium-large #1–2, Chicago Mercantile Exchange	Bloomberg
37	Live cattle/CME	55 % choice, 45 % select, yield grade 3 live steers, Chicago Mercantile Exchange	Bloomberg
38	Lean hogs/CME	Hog (barrow and gilt) carcasses, Chicago Mercantile Exchange	Bloomberg
39	Wheat/KCBT	Hard red winter wheat, no. 2, at contract price; no. 1 at a 1½-cent premium; Kansas City Board of Trade	Bloomberg
40	Wheat/MGEX	Hard red spring wheat, no. 2 or better Northern spring wheat with a protein content of 13.5 % or higher; Minneapolis Grain Exchange	Bloomberg
41	White maize/SAFEX	South African Futures Exchange; starting in 08/1996	Bloomberg
42	Yellow maize/SAFEX	South African Futures Exchange; starting in 08/1996	Bloomberg
43	Wheat/SAFEX	South African Futures Exchange; starting in 11/1997	Bloomberg
44	Soybean/SAFEX	South African Futures Exchange; starting in 04/2002	Bloomberg
45	Sunflower seeds/SAFEX	South African Futures Exchange; starting in 02/1999	Bloomberg
46	Palm oil/MDEX	Malaysia Derivatives Exchange; starting in 03/1995	Bloomberg
47	GSCI agriculture	Price index over active futures with the 2012 S&P GSCI weights on wheat (CBT), wheat (KCBT), corn, soybeans, lean hogs, live cattle and feeder cattle (all CBT)	Own calculation
48	Trade weighted country index	Price index over US corn, US HRW and Thai 5 % spot prices according to the trade shares (imports plus exports of commodity divided by imports plus exports of all three commodities) of each country	Own calculation
49	Rice/Vietnam	Vietnam, rice (25 % broken), export	FAO GIEWS
50	Rice/Vietnam	Vietnam, rice (5 % broken), export	FAO GIEWS
51	Rice/Pakistan	Pakistan, rice (25 % broken), export	FAO GIEWS
52	Rice/Pakistan	Pakistan, rice (Basmati ordinary), export	FAO GIEWS
53	Rice/USA	USA, rice (US long grain 2.4 %), export	FAO GIEWS

(continued)

Table 12.3 (continued)

w	Variable	Description	Source
54	Rice/USA	USA, rice (US California medium grain), export	FAO GIEWS
55	Rice/Thailand	Thailand: Bangkok, rice (25 % broken), export	FAO GIEWS
56	Rice/Thailand	Thailand: Bangkok, rice (5 % broken), export	FAO GIEWS
57	Rice/Thailand	Thailand: Bangkok, rice (fragrant 100 %), export	FAO GIEWS
58	Rice/Thailand	Thailand: Bangkok, rice (glutinous 10 %), export	FAO GIEWS
59	Rice/Thailand	Thailand: Bangkok, rice (parboiled 100 %), export	FAO GIEWS
60	Rice/Thailand	Thailand: Bangkok, rice (Thai 100 % B), export	FAO GIEWS
61	Rice/Thailand	Thailand: Bangkok, rice (Thai A1 Super), export	FAO GIEWS
62	Wheat/Argentina	Argentina, wheat (Argentina, up river, trigo pan), export	FAO GIEWS
63	Maize/Argentina	Argentina, maize (Argentina, up river), export	FAO GIEWS

Source: Own elaboration

Robustness Checks for Transmission to Grain Price Index

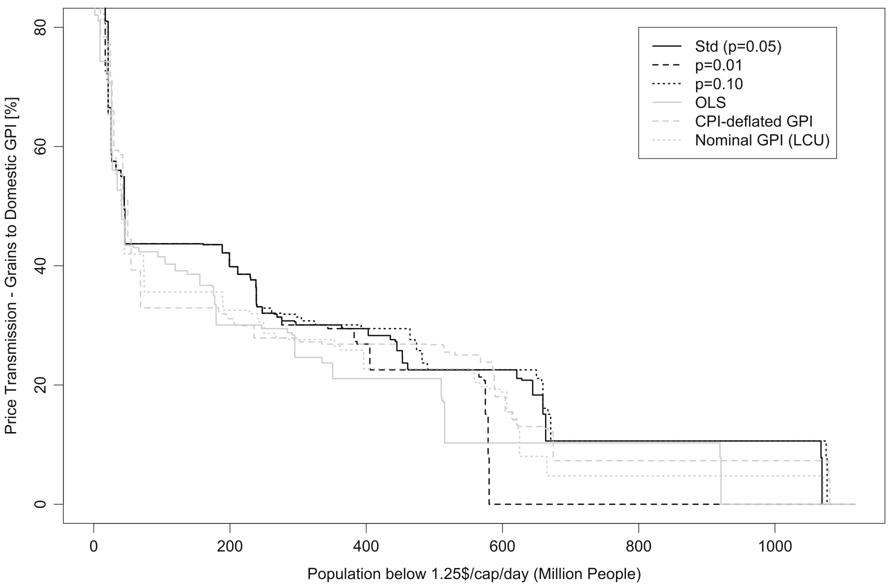


Fig. 12.7 Global price transmission to the domestic grain price index under different significance levels and model specifications. *Source*: Own elaboration

Price Transmission from Individual Grain Prices

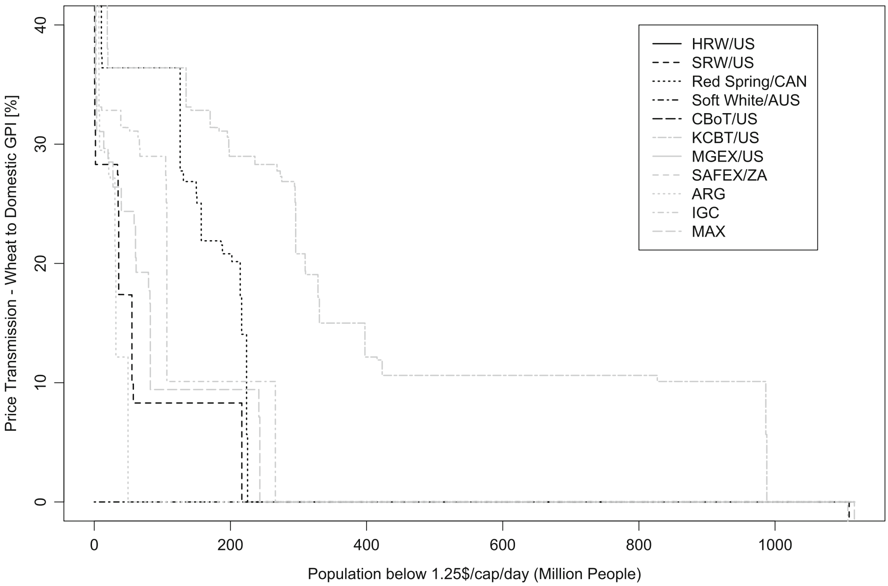


Fig. 12.8 Transmission from several international wheat prices to the domestic grain price index and affected people

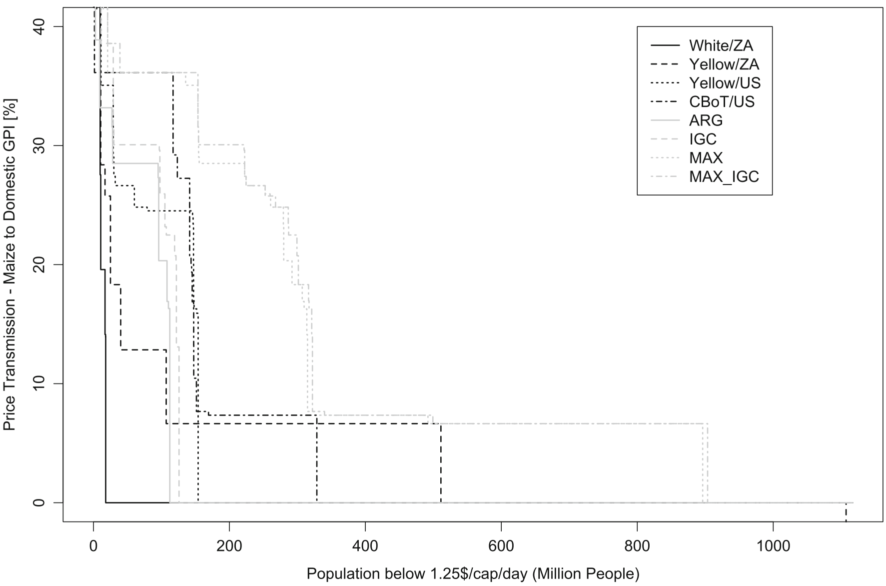


Fig. 12.9 Transmission from several international maize prices to the domestic grain price index and affected people

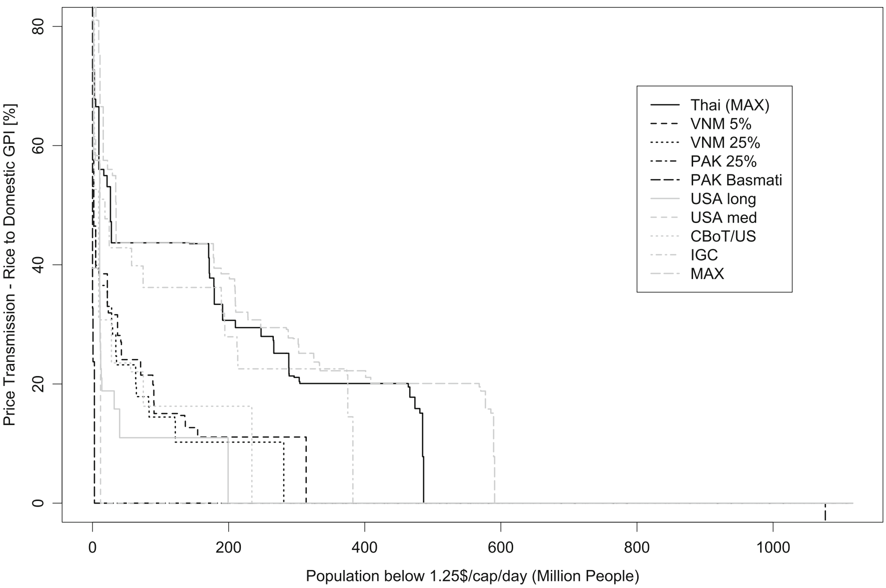


Fig. 12.10 Transmission from several international rice prices to the domestic grain price index and affected people

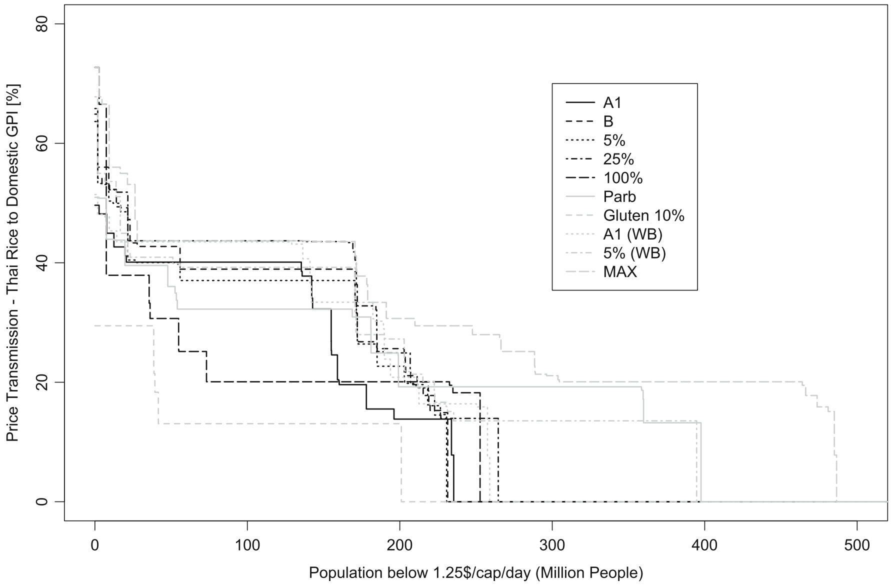


Fig. 12.11 Transmission from Thai rice prices (export) to the domestic grain price index and affected people

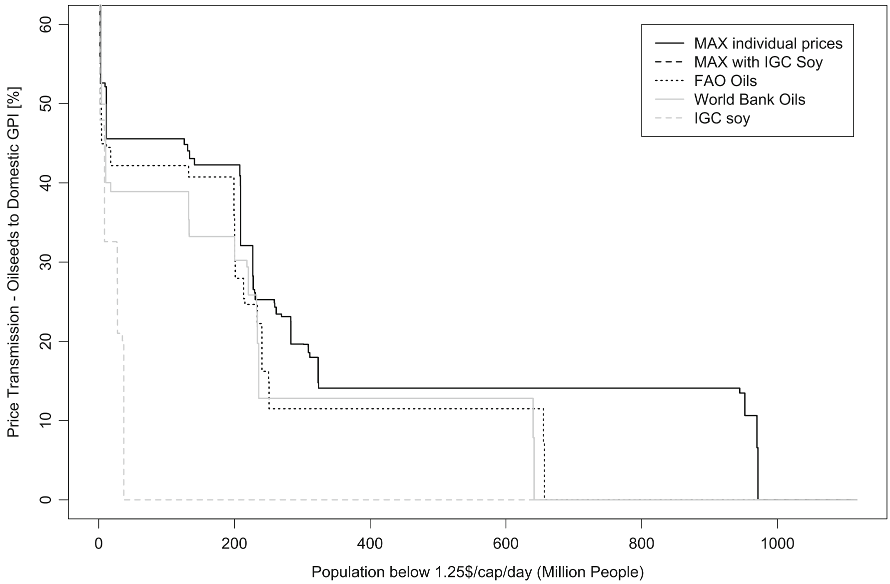


Fig. 12.12 Transmission from several international oilseed prices to the domestic grain price index and affected people

Table 12.4 Transmission elasticities of grain prices and price indices to domestic grain prices for countries with more than one million people below the poverty line

ISO3	Poor pop (Mio)	Wheat	Maize	Rice	Max (grains)	Max (US cereals futures)	FAO food	FAO cereals	WB grains	IGC grains/oils
AFG		0.30	0.46	0.37	0.46	0.28	0.71	0.52	0.50	0.51
BDI	8.0	0.00	0.26	0.16	0.26	0.00	0.00	0.00	0.00	0.00
BEN	4.8	0.28	0.00	0.55	0.55	0.00	0.00	0.00	0.00	0.00
BFA	7.3	0.00	0.00	0.28	0.28	0.00	0.00	0.00	0.00	0.00
BGD	66.9	0.15	0.30	0.22	0.30	0.15	0.76	0.33	0.00	0.31
BRA	12.2	0.31	0.22	0.40	0.40	0.00	0.61	0.36	0.39	0.35
CHN	159.4	0.10	0.07	0.23	0.23	0.16	0.42	0.32	0.32	0.00
CIV	4.7	0.00	0.00	0.67	0.67	0.00	0.00	0.00	0.00	0.00
CMR	2.1	0.18	0.21	0.00	0.21	0.17	0.00	0.32	0.24	0.29
COL	3.9	0.00	0.16	0.32	0.32	0.10	0.22	0.18	0.24	0.11
ETH	28.1	0.33	0.27	0.44	0.44	0.24	0.00	0.71	0.78	0.61
GHA	7.3	0.00	0.00	0.56	0.56	0.00	0.36	0.00	0.00	0.00
GIN	5.0	0.82	0.00	0.87	0.87	0.00	0.00	0.00	0.00	0.00
GTM	2.0	0.31	0.27	0.29	0.31	0.21	0.67	0.40	0.37	0.37
HND	1.4	0.00	0.71	0.81	0.81	0.42	0.00	0.65	0.78	0.77
HTI	6.3	0.31	0.43	0.58	0.58	0.53	0.86	0.56	0.59	0.57
IDN	40.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IND	404.1	0.11	0.07	0.00	0.11	0.11	0.19	0.00	0.00	0.00
KEN	18.7	0.27	0.25	0.31	0.31	0.31	0.00	0.41	0.35	0.00
KHM	2.8	0.00	0.00	0.81	0.81	0.81	0.74	0.00	0.00	0.00
LAO	2.3	0.27	0.00	0.19	0.27	0.00	0.00	0.00	0.00	0.00
MDG	18.1	0.19	0.39	0.25	0.39	0.27	0.42	0.38	0.34	0.40

(continued)

Table 12.4 (continued)

ISO3	Poor pop (Mio)	Wheat	Maize	Rice	Max (grains)	Max (US cereals futures)	FAO food	FAO cereals	WB grains	IGC grains/oils
MLI	7.5	0.12	0.00	0.24	0.24	0.12	0.00	0.00	0.00	0.00
MMR		0.27	0.25	0.27	0.27	0.27	0.00	0.00	0.31	0.34
MNG		0.55	0.37	0.32	0.55	0.34	0.88	0.69	0.53	0.64
MOZ	15.0	0.00	0.18	0.00	0.18	0.00	0.00	0.00	0.00	0.00
MWI	9.8	0.00	1.17	0.00	1.17	0.00	0.00	0.00	0.00	0.00
NER	7.5	0.00	0.00	0.21	0.21	0.00	0.00	0.00	0.00	0.00
NGA	114.8	0.36	0.36	0.44	0.44	0.36	0.00	0.00	0.00	0.00
NPL	6.8	0.31	0.00	0.19	0.31	0.00	0.00	0.00	0.00	0.00
PAK	37.7	0.29	0.00	0.29	0.29	0.00	0.00	0.00	0.00	0.00
PER	1.5	0.07	0.00	0.08	0.08	0.00	0.40	0.00	0.00	0.00
PHL	17.8	0.12	0.08	0.32	0.32	0.08	0.00	0.00	0.00	0.00
RUS		0.33	0.26	0.28	0.33	0.21	0.95	0.47	0.40	0.42
RWA	7.2	0.33	0.26	0.28	0.33	0.21	0.95	0.47	0.40	0.42
SDN	7.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEN	4.1	0.00	0.00	0.15	0.15	0.00	0.00	0.00	0.00	0.00
TCD	7.7	0.00	0.00	0.38	0.38	0.00	0.00	0.00	0.00	0.00
TGO	1.9	0.57	0.51	0.84	0.84	0.00	0.59	0.00	0.44	0.38
TZA	32.4	0.28	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00
UGA	13.8	0.21	0.00	0.00	0.21	0.00	0.43	0.49	0.45	0.00
ZMB	10.5	0.42	0.00	0.39	0.42	0.00	0.00	0.41	0.00	0.00
ZWE		0.00	0.00	1.54	1.54	0.00	0.00	0.00	0.00	0.00

Note: "Poor pop" refers to the number of people below the poverty line (estimated in 2012) – blank entries denote missing data. Wheat, maize, and rice refer to the maximum transmission of the commodity prices at different international markets or of different types in each of the commodity group; max(grains) is the vulnerability indicator – showing the maximum transmission over the different grain prices; max (US cereals futures) is the vulnerability indicator over commodity prices at US futures exchanges. WB refers to the World Bank's grain price index

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