Pass-Through, Food Prices and Food Security

Authors: Eddy Bekkers,[1] Martina Brockmeier,[2] Joseph Francois,[1*] Fan Yang[2]

Affiliations:

[1]Johannes Kepler University Linz.

[2]University of Hohenheim.

[*]Joseph Francois; E-mail: joseph.francois@jku.at

Abstract: The rate of food price pass-through indicates by how much local food prices follow movements in world food prices. This paper estimates the pass through across countries with different levels of income using FAO world food price index data and ILO local consumer price index data on 147 countries. We find that the rate of pass through from world food prices to final consumption prices for rich, middle-income and poor countries are respectively 0.12, 0.25 and 0.29. A larger rate of pass through in low income countries reflects a larger share of primary food in consumed food and a smaller role for margin services. Employing a CGE model we show that the higher share of margin services plays an important role in stabilizing consumer prices for food in rich countries. Our results imply that the vulnerability of poor countries to food price shocks will rise as emerging countries grow richer.

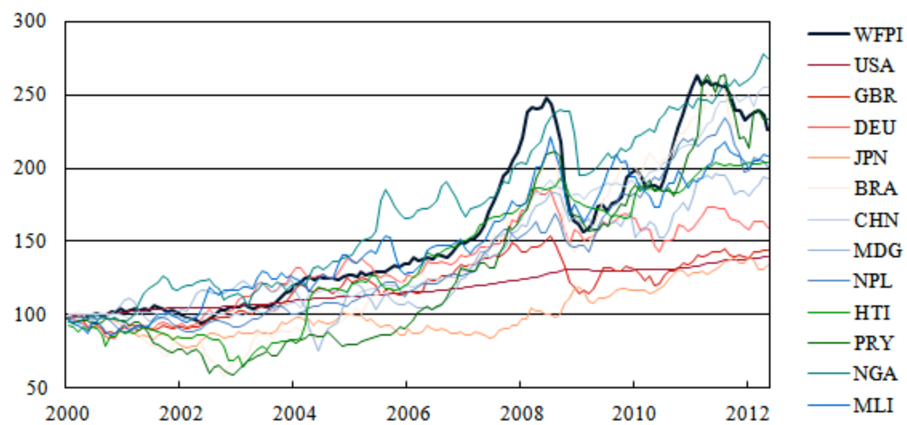
The authors acknowledge support from the EC under the FP7 project GIQ: impacts quantification of global changes, grant no 266992

One Sentence Summary: Local food prices are more sensitive to world food price movements in poor countries than in rich countries, reflecting a larger share of primary food in consumed food.

The commodity crisis of 2007/2008 and 2010/2011 underscores the vulnerability of the global food system to shocks from diverse sources: weather events, disruption in energy and financial markets, increased production for bioenergy, larger meat demand in emerging countries, exchange rate movements and low stock level expectations (e.g. *1-4*). Soaring food prices affected poverty considerably especially in urban areas of food importing countries (*5-7*) resulting in some cases to social unrest. This led in turn to protectionist measures in many countries to insulate them from the rising food prices. *8* has stressed that the political demands of developing countries and Non Government Organizations (NGOs) in this regard are actually inconsistent over time. There were consistent demands for changes in food policy in the Organization for Economic Co-operation and Development (OECD) that led, predictably, to food price increases. These increases have themselves been criticized by the same combination of NGOs and developing countries thereafter.

Crucial in the determination of the impact of soaring world food prices is the food price pass-through, the extent to which changes in world food prices led to changes in local food prices. Fig. 1 shows that pass-through is imperfect and that countries differ a lot in the extent to which local food prices follow world food prices. Surveys of the earlier literature on food price pass-through can be found in (*9, 10*) and the broader question of spatial price transmission is discussed in (*11*). A large part of the literature has concentrated on variation in the degree of integration of local food markets into world markets to explain variation in food price pass-through. Market integration varies as a result of trade costs, often the result of government policy (e.g. *12-14*). More studies on food price transmission emerged in the aftermath of the episodes of soaring food prices studying the influence of market structure, transaction costs, trade policies and exchange rate movements (*15-21*). These studies only explored pass-through in single countries or a small set of countries. (*11*) estimate pass-throughs in more than 70 countries, but do not formally relate the pass-through to levels of income.

Fig. 1 Food Price Index development (2000=100, nominal in US$ terms)



Source: FAO, ILO, 2013.

Fig. 1 suggests that the level of income has a huge impact on food price pass through. Final consumption prices include not only the final commodities themselves, but also the service inputs (transport, distribution, food processing services) that convert basic commodities into final, delivered consumption goods. These margin activities are more expensive in high-income countries, yielding insulation from volatility of commodity prices at the final consumption level. As a result, local food prices in rich countries like the USA and Germany seem to be much less responsive to world food prices than local food prices in poor countries like Mali, Paraguay and China.[1]

In this article we study the impact of margin services and per capita income levels on food price pass-through. We employ a worldwide sample of data including 147 countries over 156 months from 2000 - 2012. Panel analysis for three country groups (rich, middle-income and poor countries) shows that food price pass-through varies largely with per capita income levels. Support for this interpretation follows from an examination of the share of primary food in final food consumption in the GTAP national account data (*24*). With a CGE analysis we further confirm that the smaller share of margin services in food consumption and the larger share on

[1] (*22, 23*) study the role of margin services in exchange rate pass through, but do not relate this to the level of income.

food in poor countries, consumers in these countries are naturally more exposed to world food price crises.

Econometric Analysis of food price pass-through

Methodology and Data

Consumed food consists of primary food traded on the international market like wheat, meat and milk and additional margin services not traded internationally such as shipping, local processing, storage, and distribution. Rich countries will display a larger share of margin services and thus a lower share of primary food. There are two main reasons. First, as consumers get richer they demand higher quality food, requiring more inputs besides primary food. Second, labor used intensively in margin services is more expensive in rich countries due to the Balassa Samuelson effect (25, 26). The implication is that the pass through of world food price changes to local consumer food prices is smaller in richer countries.

To estimate the long run pass-through we follow most of the literature on exchange rate pass through (27, 28) and regress first differences of the local food price index on the first difference of the world food price index and various lags[2,3]:

$$\Delta logCPI_{it} = \sum_{k=0}^{K} \beta_k \Delta \log WFPI_{t-k} + \sum_{k=0}^{K} \gamma_k \Delta logFX_{it-k} + \eta_i + \varepsilon_{it} \quad (1)$$

CPI_{it} is the consumer food price index in country i in period t, $WFPI_t$ the world food price index and FX_{it} the exchange rate of country i in period t vis-a-vis the dollar. η_i is a country fixed effect. We split the sample of countries into three groups, rich, middle income and poor, and estimate equation (1) with country fixed effects[4]. We allow for heteroskedasticity across countries and for AR1 disturbances.

The long run pass-through of the international food price index to the local food price index in country i is equal to the sum of pass-through coefficients, $\sum_{k=0}^{K} \beta_k$. To determine the number of lags we follow the rule by (*28*) that the long run elasticity does not change anymore adding more lags. This rule generates a lag length of 15. We allow for different pass-through coefficients of the world food price β_k and the exchange rate γ_k since tests of equality of the world food price and exchange rate pass-through strongly reject the hypothesis that the two pass-throughs are equal. In the exposition below, we concentrate on the long run pass-throughs of the world food price.

[2] Panel unit root tests imply that we should estimate in first differences..

[3] Others have estimated the pass through with a cointegration framework (*12, 17, 18, 29, 30*). We do not use this framework, since local food prices do not comove with world food prices due to poor market integration (see for further discussion *31* and *32*).

[4] The long run pass through following from a country fixed effects regression per income group is a consistent estimator of the average pass through in the income group, also with differences in the pass through within the income group. Parameter heterogeneity leads to biased results in dynamic panels with lagged dependent variables included in the regression (*33*), but we do not work with lagged dependent variables.

Our final dataset contains monthly data over the period 2000-2012 for 147 countries. We use the world food price index composed by the FAO to measure $WFPI_t$. We work with the consumer food price index composed by ILO as a measure for CPI_{it}. The exchange rate data are from the IMFIFS and the World Bank. The three different income groups are based upon the World Bank classification of countries into poor (less than \$770 per capita GDP at year 2000 prices), middle income (\$770-\$9300 per capita GDP) and rich countries (more than \$9300 per capita GDP). Detailed data sources are provided in Appendix.

Estimation Results

Table 1 displays the estimated average long run pass-through for the three income groups rich, middle income and poor. Differences in long run pass-through between rich and middle (p-value of 0.00) and between rich and poor (p-value of 0.00) are very significant, whereas the difference between middle and poor is not significant (p-value of 0.34). The difference between poor and middle becomes strongly significant (p-value of 0.00) when including slope dummies for Africa.

Table 1: The long run pass through in the different income groups both for all periods and sepearating between low and high volatility periods

Income group	LRPT	LRPT high volatility
Rich	0.12***	0.043**
	(0.0084)	(0.021)
Rich high volatility		0.10***
		(0.023)
Middle	0.25***	0.19***
	(0.014)	(0.032)
Middle high volatility		0.097***
		(0.035)
Poor	0.29***	0.21***
	(0.030)	(0.074)
Poor high volatility		0.065
		(0.081)
Poor Africa	0.26***	0.16*
	(0.034)	(0.089)
Poor Africa high volatility		0.070
		(0.098)
Poor non-African	0.39***	0.34***
	(0.055)	(0.13)
Poor non-African high volatility		0.077
		(0.14)

Standard errors in parentheses

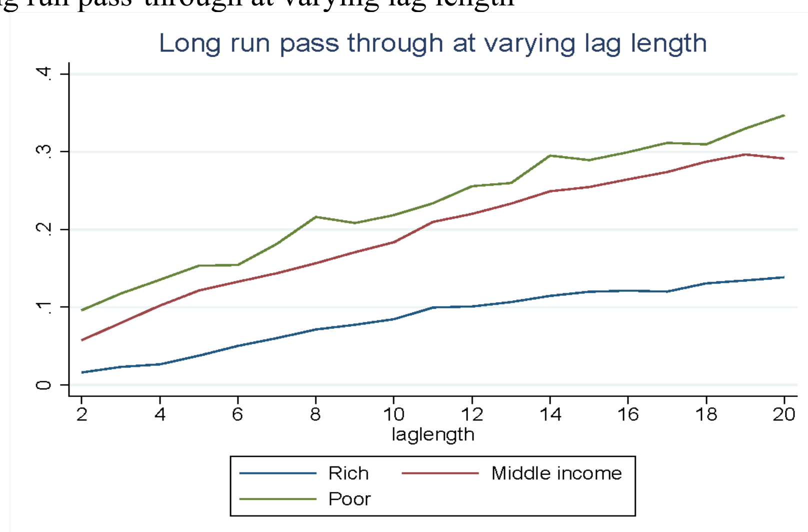
*p < 0.10, **p < 0.05, ***p < 0.01

Source: Own estimation results.

The long run pass-through in Africa is 0.15 smaller on average than in the rest of the world, a strongly significant difference (p-value of 0.00). The lower pass-through in Africa also follows from the results of panel regressions displayed in the bottom rows of table 1 for poor African and poor non-African countries separately.[5]

Fig. 2 displays how the long run pass-through develops as the number of lags included in the regressions rises. We see that the long run pass-throughs in the three income groups are different for all lag lengths.[6] Testing the difference in long run pass-throughs across the three income groups shows that differences between the rich and middle income groups and between rich and poor income groups are highly significant at varying lag lengths. The difference between middle and poor income groups is not significant for most lag lengths. The difference in pass through between countries from the different income groups reflects the share of primary food in total food consumption. In the next section we calculate the share of primary food in total food consumption (including margin services) using GTAP national accounts data showing that the food share is more than three times as large in poor countries than in rich countries.

Fig. 2 The long run pass-through at varying lag length



Source: Own estimation results.

With the soaring food prices starting in 2007, food prices became much more volatile between 2007 and 2011. So, we explore whether the long run pass through was different in this period by allowing for a different intercept and a different slope in the period of high volatility (from April 2007 until February 2011)[7]. The second column of table 1 displays the basic pass through and

[5] The difference in long run pass through between poor African countries and poor non-African countries is smaller than the difference in long run pass through for the entire sample, as there are also African middle income countries where the difference is even larger.

[6] The presented figure is not an impulse response function but displays the total effect (long run pass through) for estimations with a different number of lags included. Its goal is to show that the differences between rich countries on the one hand and middle income and poor countries on the other hand in terms of lag length appears for estimations at all lag lengths.

[7] This period is chosen based upon an analysis of the variance of the world food price, which is about four times as large as in the rest of the sample period.

excess pass through for the period with high volatility. In the rich and middle-income countries, the pass through is significantly larger in the high volatility period, whereas the difference is not significant in the poor countries. A possible explanation for this finding is that there was a stronger policy reaction in poor countries in the high volatility period to limit the impact of the world food price increases.and poor income groups is not significant for most lag lengths.

Simulation with GTAP Framework

Empirical Design

Given that a great number of literatures studying price transmission focus on econometric analysis as discussed above. (*29*) suggest utilizing the transmission elasticity as background information for equilibrium modeling. Here we employ GTAP, which is a multi-regional CGE model that captures world economic activity in 57 different industries of 134 regions (Version 8.1 of the database, base on world economy in 2007). It assumes perfect competition and constant returns to scale while bilateral trade is handled via the Armington assumption (*24*). The underlying set up of GTAP is similar to other CGE models. Given its broad cover of data and simple but firm economic assumptions, GTAP has obtained growing attention in policy analysis under a global context. Recent global food price crisis inspires a body of literatures utilizing GTAP in studying poverty and food security under trade policy changes (e.g. *34, 35*).

Despite its formidable performance, one underlying assumption in GTAP indicating complete price transmission tends to generate less accurate results. (*36*) validate GTAP model using wheat price volatility and amends their simulations by accounting price transmission elasticity resulted from policy reform. (*37*) account for scale economies in GTAP which allows price to be monopolized under imperfect competition. Yet standard GTAP model ignores the bundling of margin services and commodities in final consumption by treating them as individual sectors. Econometric results in earlier chapter suggest that a great deal of incomplete price transmission stems from local delivered margin cost. This motivates us to merge the purchased goods and their attached service in the final stage of consumption and assess how this modification alters the price transmission.

As mentioned in equation **Error! Reference source not found.**, the pass-through rate provides an estimate for the share of internationally traded food in final food consumption. Therefore, we first compare our econometric analysis with the share of food without processing (whose price movements are more closely compared with the internationally traded food) in total food consumption using the GTAP national account data. To reckon this share, GTAP sectors are aggregated into primary food, processed food, other consumed commodities, margin and other services (Table A…). By assigning the value of margin service evenly across final consumed goods, we obtain the complete value of final consumption, which are named "margin-goods" (for food it is "margin-food"). If the margin in each margin-food is $MSHARE$ (Table 2 Row 2), $1-MSHARE$ stands for the share of food beside margin. Since consumers buy both food with and/without processing, the share of internationally traded food in the final "margin-food" (s_{pf}) becomes:

$$s_{pf} = P_{primfood,food} * (1-MSHARE) + F_{food,procfood} * P_{procfood,food} * (1-MSHARE) \qquad (2)$$

F and P represent cost structure of firms and households, and lower cases indicate the ratios of former term in later term of production/consumption, meaning $P_{primfood,food} + P_{procfood,food} = 1$. The first term of the equation captures the value of primary food directly consumed while the second term includes share of food that are processed before final consumption. Table 2 displays the results for *MSHARE* and s_{pf}. As countries get richer, their shares of margin services correspondingly rise and the food share fall. This pattern is consistent with our econometric analysis. Note that the pass-through rates estimated before are with lower values. Possible explanations are resulting from: 1) Other factors (e.g. trade policies) cause imperfect market integration that reduce empirical price pass-through; 2) The commodity components vary between those included in price index and in GTAP sectors resulting in different shares.

Table 2: GTAP implied pass-through and cost shares

	low-income	middle-income	high-income
MSHARE	0.153	0.249	0.385
s_{pf}	0.606	0.478	0.269

Source: Own estimation results.

Now that the "margin-goods" replace the original traded commodities in GTAP, we calculate the new share of private consumption devoted to margin-goods *MCONSHR* using equation (3). With *MCONSHR*, we mirror the new coefficients according to the standard CED coefficients (*24*) in private household demand system. Assuming Leontief preference between goods and margins (we consider them as perfect complements at current stage of the research), the quantity change for consumed margin-good *mqp* depends solely on the change of good *qp* (equation (4)) while the price change *mpp* for the final consumption is determined concurrently by delivered margins and goods (equation (5)). Additionally, we fix the share of total private consumption expenditure according to Cobb-Douglas assumption. Here are the core functions that are included (lower case indicates percentage change, i, m, mi and r represent traded goods, margins, margin-goods and regions, respectively; *SHARE* stands for the original share of private consumption devoted to i in r):

$$MCONSHR(mi,r) = [1 + MSHARE(r) / (1 - MSHARE(r))] * SHARE(i,r) \tag{3}$$

$$mqp(mi,r) = qp(i,r) \tag{4}$$

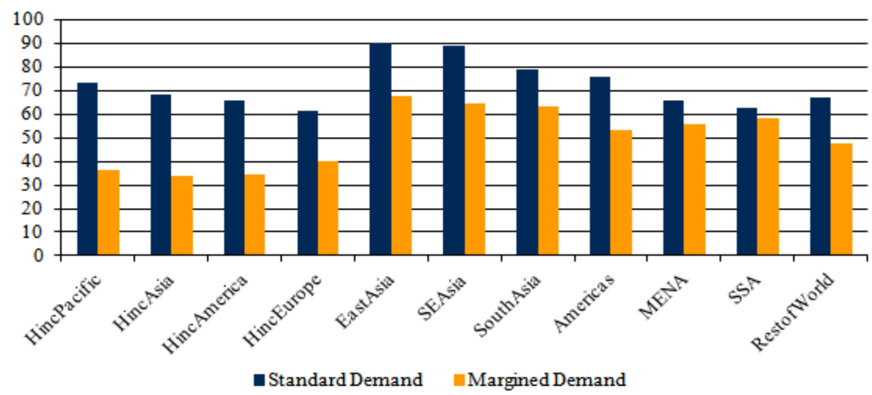
$$mpp = [1 - MSHARE(r)] * pp(i) + MSHARE(r) * pp(m) \tag{5}$$

After updating the demand structure, we disaggregate the data into 11 regions and 9 industries for the simulations. (Appendix A). According to FAO, average global agricultural and food price indices escalated by around 70% from the beginning of 2007 until the middle of 2008. Therefore, by simulating the same amount of world price shock for sectors ”PrimFood” and ”Procfood”, we design two scenarios: one with standard GTAP; the other one with modified GTAP that embodies margin effect. Since price is treated as an endogenous variable in the model, we swap world prices with the the rate of technical change of the food sectors worldwide, so that the model reduces food production globally by an amount sufficient to raise food price.

Simulation Results

The simulated price volatilities across regions are shown in Fig. 3. As aforementioned, consumers buy both primary and processed food, thus we calculate the weighted food price changes for different regions according to the share of those two items. With standard GTAP model, shock of world food price disperses among regions, with the highest impact in Asia. Possible explanation is that primary food production in Asia is land-intensive and the production of processed food use a considerable share of primary food (amount to 40%, the highest among all the regions), which reinforces the price movements between those two. Decomposing the results also shows that the world price increase of primary food contributes to on average about 15% increase of processed food price. Apart from Asia, pass-through rates are roughly even. On the other hand, when margin is accounted in the simulation, price transmission is less significant for all regions compared with standard scenario. For rich countries (e.g. high income Asia, high income America), the extent of price changes is scaled down by almost half; whereas in poor regions (such as Sub-Sahara Africa), margin effect is less noticeable. Consequently, rich regions that are more integrated into world market exhibit much less pass-through. Results correspond with our econometric analysis. Greater shares of margin service insulate consumers in high-income countries from the price surge in world market.

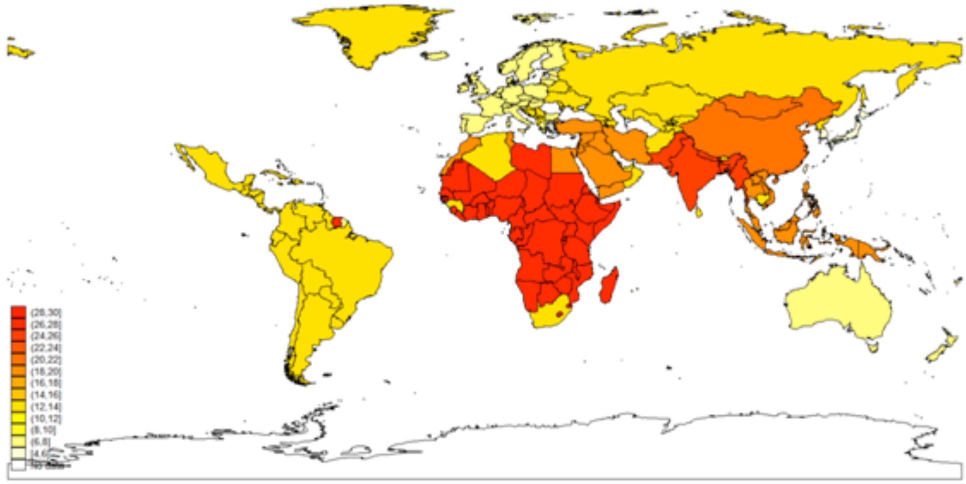
Fig.3 Percentage change of consumer prices for food (global 70% price increase)



Source: Own calculation based on GTAP simulations

To exam the overall impact of food price increase, Fig. 4 uses a map to illustrate the weighted average change of consumer price index. The darker the red, the higher the change of CPI for that country. Interestingly, areas witness high food prices also face greater turbulence in their CPI inflation (e.g. SSA, India), while rich countries in the northern Hemisphere only have around 3% CPI changes. Certainly, results are associated to that consumers in poor countries distribute greater amount of their household income to purchase food. For instance, countries in SSA where food expenditure accounts for half of the total expenditure have higher CPI growth than Asia, where this share is less than 30% on average. Consumers in industrialized countries are even less sensitive to the price change of food basics, when their total expenditure on food is less than 10% (according to GTAP national account data, 2007).

Fig.4 Overall consumper price index change (global 70% price increase)



Source: Own calculation based on GTAP simulations

Concluding Remarks

In this paper we studied the transmission from international food prices to final consumer prices. Employing monthly CPI data on food commodities between 2000 and 2012, we found that food price pass-through varies largely with income per capita levels. Consumers in rich countries are largely insulated from world food price volatility, as a result of a greater share of margin services in consumed food.

Accounting the margin impact in GTAP significantly reduced the price transmission rates in rich countries. The CGE analysis is in line with the econometric estimation. Food commodities coupled with high share of margin services in rich economies experience less price transmission while consumers from poor economies are more responsive to the volatility of international prices. Furthermore, the higher share of expenditure share on food in poor countries makes them even more vulnerable.

Consequently, food policies that are seen as essential measures combat world food price volatility should be combined with more efficient measures that stimulate economic growth. More policy indications ADDED BY MARTINA AND JOE.

References and Notes:

1. J. von Braun, The world food situation: New driving forces and required actions (Food Policy Rep., IFPRI, Washington, DC, 2007).

2. C. P. Timmer, Causes of high food prices (ADB Economics Working Papers Series 128, Asian Development Bank, Manila, 2008).

3. P. C. Abbott, C. Hurt, W. E. Tyner, What's driving food prices? (Farm Foundation Iss. Rep., 2008), What's driving food prices? March 2009 update (Farm Foundation Iss. Rep., 2009), What's driving food prices in 2011? (Farm Foundation Iss. Rep., 2011).

4. B. D. Wright, The economics of grain price volatility. Appl. Econ. Perspect. Pol. 33(1), 32-58 (2011), doi: 10.1093/aepp/ppq033.

5. S. Dessus, S. Herrera, R. De Hoyos, The impact of food inflation on urban poverty and its monetary cost: some back-of-the-envelope calculations.Agr. Econ. 39(s1), 417-429 (2008).

6. M. Ivanic, W. Martin, Implications of higher global food prices for poverty in low-income countries. Agr. Econ. 39(1), 405-416 (2008).

7. M. Ivanic, W. Martin, H. Zaman, Estimating the short-run poverty impacts of the 2010--11 surge in food prices.World Dev. 40(11), 2302-2317 (2012).

8. J. M. Swinnen, P. Squicciarini, Mixed messages on prices and food security. Science 335(6067), 405-406 (2012).

9. J. Meyer, S. Cramon-Taubadel, Asymmetric price transmission: a survey. J. Agr. Econ. 55(3), 581-611(2004).

10. P. Vavra, B. K. Goodwin, Analysis of price transmission along the food chain (OECD Food, Agriculture and Fisheries Working Papers No. 3, OECD, Paris, 2005).

11. P. L. Fackler, B. K. Goodwin, in Handbook of Agricultural Economics, B. L. Gardner, G. C. Rausser Eds.(Elsevier, 2001), vol. 1, 971-1024.

12. J. Baffes, B. Gardner, The transmission of world commodity prices to domestic markets under policy reforms in developing countries. J. Polit. Econ. 6(3), 159-180 (2003).

13. R. J. Myers, T.S. Jayne, Multiple-regime spatial price transmission with an application to maize markets in Southern Africa. Am, J. Agr. Econ. 94(1), 174-185 (2011).

14. G. Ferrucci, R. Jiménez-Rodríguez, L. Onorante, Food price pass-through in the Euro area: non-linearities and the role of the Common Agricultural Policy. IJCB8(1), 179-217 (2012).

15. IMF, World Economic Outlook (WEO): Slowing Growth, Rising Risks (World Economic and Finanacial Survey, International Monetary Fund, 2011).

16. D. Dawe, Have recent increases in international cereal prices been transmitted to domestic economies? The experience in seven large Asian countries (Working Paper 08-03, FAO-ESA, 2008).

17. C. Godsway, C. Breisinger, X. Diao, Local impacts of a global crisis: food price transmission, consumer welfare and poverty in Ghana. Food Policy 35(4), 294-302 (2010).

18. N. Minot, Transmission of world food price changes to African markets and its effect on household welfare (IFPRI Discussion Paper 1059, International Food Policy and Research Institute, Waschington, DC, 2010).

19. R. Rigobon, Commodity prices pass-through (Working Papers 572, the Central Bank of Chile, Santiago, 2010).

20. A. Ghoshray, Underlying trend and international price transmission of agricultural commodities (ADB Economics Working Paper Series No. 257, ADB, Manila, 2008).

21. K, Baltzer, International to domestic price transmission in fourteen developing countries during the 2007-08 food crisis (Wider Working Paper 031, UNU, Helsinki, 2013)

22. A. T. Burstein, J. C. Neves, S. Rebelo, Distribution costs and real exchange rate dynamics during exchange rate based stabilizations, J. Monetary Econ.50, 1189-1214 (2003).

23. Francois, J., Manchin, M., and Norberg, H. (2013): Distribution Services and the Impact of Trade on Producer and Consumer Prices. Mimeo Johannes Kepler University Linz.

24. T. W. Hertel, M. E.Tsigas, in Global Trade Analysis: Modeling and Applications, T. W. Hertel, Ed. (University Press, Cambridge, 1997), pp. 13-73.

25. W. J. Baumol, Macroeconomics of unbalanced growth: The anatomy of urban crisis. Am. Econ. Rev. 57(3), 415-426 (1967).

26. B. Balassa, The Purchasing-Power Parity doctrine: A reappraisal. J. Polit. Econ. 72(6), 584-596 (1964).

27. J. M. Campa, L. S. Goldberg, Exchange rate pass through into import prices. Rev. Econ. Stat. 87(4), 679--690 (2005).

28. E. Nakamura, D. Zerom, Accounting for incomplete pass-through. Rev. Econ. Stud. 77(3), 1192-1230 (2010).

29. P. Conforti, price transmission in selected agricultural markets (FAO Commodity and Trade Policy Research Working Paper No.7, FAO, Rome, 2004).

30. Gilbert Christopher L. (2010). Food Prices in Six Developing Countries and the Grains Price Spike, mimeo University of Trento.

31. C, Adam, On the macroeconomic management of food price shocks in low-income countries. J. Afr. Econ. 20(1), 63-99 (2011).

32. E. Ianchovichina, J. Loening, C. Wood, How vulnerable are Arab countries to global food price shocks? (World Bank Policy Research Working Paper 6018, World Bank, Washington, DC. 2012).

33. D. Robertson, J. Symons, Some strange properties of panel data estimators.J. Appl. Econometr. 7, 175-189 (1992).

34. K. Anderson, M. Ivanic, W. Martin, Food price spikes, price insulation and poverty (CEPR Discussion Paper No. DP9555, Center for Economic Policy Research, London, 2013)

35. M. Rutten, L. Shutes, G. Meijerink, Sit down at the ball game: How trade barriers make the world less food security.Food Policy 38(2), 1-10 (2013).

36. E. Valenzuela, T. W. Hertel, R. Keeney, J. Reimer, Assessing global computable general equilibrium model validity using agricultural price volatility. Am. J. Agr. Econ. 89(2), 383-397 (2007).

37. J. F. Francois, D. W. Roland-Holst, in Applied Methods for Trade Policy Analysis: A Handbook, J. F. Francois, K. A. Reinert Eds. (Cambridge University press, 1997), 331-363.

38. International Labour Organization (2004): Consumer Price Index Manual. Theory and Practice.

Acknowledgments:

Fig. 1. The figure caption should begin with an overall descriptive statement of the figure followed by additional text. They should be immediately after each figure. Figure parts are indicated with capital letters (**A**). If you prefer, you can place both the actual figures and captions logically through the text near where they are cited rather than at the end of the file (but not both). If a paragraph in the main text begins with the name of a figure, write out "Figure" in full (e.g., <para>"Figure 1 shows….")

Fig. 2. You can place graphics above each equation as part of this file.

Table 1. Start this caption with a short description of your table. Format tables using the Word Table commands and structures. Do not create tables using spaces or tabs characters.

Supplementary Materials:

Materials and Methods

Figures S1-S#

Tables S1-S#

Movies S1-S#

Audio Files S1-S#

External Databases S1-S#

References (##-##)

Data Sources

This section describes details on the data. In turn we discuss the local consumer food price index, the world food price index, the exchange rate data and the income per capita data. We follow the exposition in Bekkers, et al. (2013) applying the same dataset. The data availability and CPI rebasing procedures are detailed in Table A.1.

Local Food Consumer Price Index

Website: http://laborsta.ilo.org/ Select Consumer Price Indices

Consumer price indices of food commodities are from ILO. The ILO collects monthly data on the food component of 196 CPI series. The data are provided by the national statistical agencies and based upon the local definition of the CPI. Still, CPI indices have to comply with certain international standards agreed upon within the ILO. See for further discussion *38*. Some countries report more than one CPI (for different regions) and in that case we selected the series representing the whole country or if not available representing the region with the majority of the population. As a result, the sample of CPI series falls to 192.

Several reported series contain different base years. To account for this we adopted three different rebasing methods according to data availability. 1) CPIs with overlapping series were rebased using the CPI ratio in the overlapping period. 2) for indices based on different years without overlapping periods, we used the growth rate from period t-2 and t-1 to interpolate the value for period t, with t the period in which another base year begins.The remainder of the series is then rebased multiplying by the ratio of the old and the new value in period t. 3) there are some series for which some months were missing. We interpolated the missing values by assuming that CPIs changed at a constant rate in the missing periods from the last period for which data were available to the next period in which data were available. After the rebasing all CPI series have as base year 2000, i.e. the index is equal to 100 in 2000.

Exchange Rates:

Websites: http://www.imf.org/external/data.htm and http://data.worldbank.org/

Historical exchange rates are drawn from IMF and the World Bank. When monthly exchange rates are not available, annual series are extrapolated. Due to the lack of exchange rate data, we had to drop the three countries Azerbaijan, Ecuador and Tuvalu, thus reducing the sample to 189.

Ten more countries were dropped from the sample for various reasons. Antigua and Barbuda and Saint Kitts and Nevis were dropped as these countries only have 2 respectively 1 year of food price index data. Australia, Belize, Bhutan, Kiribati, Papua New Guinea and Vanuatu were dropped as there are only quarterly or semi-annual data for these countries. Zimbabwe was dropped because of hyperinflation. Myanmar was dropped since the strongly upward trend in food prices cannot be accounted for by world food prices and exchange rates. So, there seems to be a big problem with the exchange rates data for this country. So, for the estimations we are left with 179 countries.

World Food Price Index

Website: http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/

The price of internationally traded food is attained from the world food price index (WFPI) composed by FAO. The website states: 'The FAO Food Price Index is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices (representing 55 quotations), weighted with the average export shares of each of the groups for 2002-2004.'

Income Data

Website: http://data.worldbank.org/.

We use GDP per capita in PPP terms. The three income groups are low (less than $770 per capita GDP at year 2000 prices) defined as group "poor", lower and higher middle income ($770-$9300) defined as group "middle" and high income defined as group "rich" (more than $9300). 30 more countries have no available data on per capita income, which result in our final data sets including 149 countries.

Table 3: Annex Table A.1 Data availability and processing

Albania[2]	Congo[1]	Honduras	Moldova[2]	Slovakia
Algeria	Cook Islands[*]	Hong Kong, China[2]	Mongolia[2]	Slovenia
American Samoa[*]	Costa Rica[3]	Hungary	Morocco[1,2]	Solomon Islands
Andorra[*]	Croatia	Iceland	Mozambique	South Africa[1]
Angola[2]	C™te d'Ivoire[2]	India	Myanmar[1,2***]	Spain[1,2]
Anguilla[*]	Cuba[*]	Indonesia	Namibia[2]	Sri Lanka[1]
Antigua and Barbuda[***]	Cyprus	Iran[2]	Nepal[2]	St. Helena[*]
Argentina	Czech Republic[2]	Ireland	Netherlands[2]	St. Kitts and Nevis[2***]
Armenia	Denmark	Isle of Man[*]	Netherlands Antilles[*]	St. Lucia
Aruba[*]	Dominica[2]	Israel	New Caledonia[*]	St. Vincent and the Grenadines
Australia[***]	Dominican Republic	Italy	New Zealand	Suriname
Austria	Ecuador[2**]	Jamaica	Nicaragua[1]	Swaziland
Azerbaijan[**]	Egypt[2]	Japan	Niger[2]	Sweden
Bahamas[1]	El Salvador[2]	Jersey[*]	Nigeria	Switzerland
Bahrain[2]	Equatorial Guinea[2]	Jordan	Niue[*]	Syrian Arab Republic
Bangladesh	Estonia[2]	Kazakhstan	Norfolk Island[*]	Taiwan
Barbados	Ethiopia[2]	Kenya[1]	Northern Mariana Islands[*]	Tanzania[2]
Belarus[1]	Faeroe Islands[*]	Kiribati[***]	Norway[2]	Thailand
Belgium	Fiji	Korea, Republic of[2]	Oman	Togo[2]
Belize[***]	Finland[2]	Kuwait	Pakistan	Tonga
Benin	France	Kyrgyzstan	Panama[3]	Trinidad and Tobago
Bermuda[*]	French Guiana[2]	Laos[2]	Papua New Guinea[***]	Tunisia
Bhutan[***]	French Polynesia[2]	Latvia	Paraguay[2]	Turkey[1,2]
Bolivia	Gabon[2]	Lesotho	Peru[2]	Tuvalu[**]
Botswana	Gambia	Lithuania	Philippines[2]	Uganda
Brazil[2]	Georgia	Luxembourg	Poland[2]	Ukraine[2]
British Virgin Islands[*]	Germany[2]	Macau, China[*]	Portugal	United Kingdom
Brunei Darussalam[2]	Ghana	Macedonia	Puerto Rico[*]	United States
Burkina Faso	Gibraltar[*]	Madagascar	Romania	Uruguay
Burundi	Greece	Malawi	Russian Federation	Vanuatu[***]
Cambodia[2]	Greenland[*]	Malaysia	Rwanda	Venezuela[2]
Cameroon	Grenada	Maldives[2]	RŽunion[*]	Viet Nam
Canada	Guatemala	Mali[2]	Samoa	West Bank and Gaza Strip[*]
Cayman Islands[*]	Guam[*]	Malta	San Marino[*]	Zambia[1]
Central African Republic	Guadeloupe[2*]	Marshall Islands[*]	Saudi Arabia	Zimbabwe[2***]
Chad	Guinea	Martinique[*]	Senegal[2]	
Chile[2]	Guinea-Bissau[2]	Mauritania	Seychelles	
China	Guyana	Mauritius	Sierra Leone[1]	
Colombia	Haiti	Mexico	Singapore	

Motivation Specification

In this section we discuss in turn unit root tests on the food price indices, the selection of lag length and tests on differences of the world food price and exchange rate pass through.

Annex Table B.1: **Fisher-type unit-root test**

	Statistic	p-value
Inverse χ^2 (294) *P*	226.8330	0.9986
Inverse normal *Z*	13.8464	1.0000
Inverse logit t(724) *L*	13.8161	1.0000
Modified inv. χ^2 *Pm*	-2.7699	0.9972

Based on augmented Dickey-Fuller tests

Ho: All panels contain unit roots

Ha: At least one panel is stationary

No of panels = 154, Avg no of periods = 133.71

JOE SEND STATA CODE USED TO INCLUDE UPDATED PANEL UNIT ROOT TEST

We evaluate the presence of a unit root in the levels of the local food price indexes with a panel test. Table B.1 shows the results of a Fisher type unit root test: the null hypothesis that all panels contain a unit root cannot be rejected. Repeating the same exercise with first differences of the local food price indices, we can strongly reject a unit root (table **Error! Reference source not found.**).

INSERT unitrootpanelfirst

The lag length is selected applying the rule in *28* that adding additional lags does not change the long run pass through anymore. We implemented this rule by estimating the fixed effects models for rich, poor and middle income countries starting from one lag of world food prices and exchange rates as regressors adding each time one lag until the change in the long run pass through relative to estimation with the average of one and two lags less does not exceed a certain threshold anymore (2%). This rule generates 17 lags for the rich countries, 20 lags for the middle income countries and 10 lags for the poor countries. Fig. 2 shows how the estimated long run pass throughs evolve as more lags are added to the regression. Based on the outcome of the test using the rule by *28* and inspection of figure **Error! Reference source not found.** we decided to work with 15 lags in the main analysis.[8]

[8] We also checked how many lags AIC and BIC criteria suggest, but these statistics were not very useful for the problem at hand. The BIC and AIC kept on falling as more lags were added to the regression (we checked up to 30 lags). Probably the degrees of freedom penalty is not strong enough for the panel estimation procedure used, given that there is strong parameter heterogeneity. We did not explore the AIC and BIC criteria in the country by country regressions, since we used the *28* rule as our main guide in the selection of lag length.

Equality of the world food price and exchange rate pass through is tested by estimating the fixed effects models in the three income groups rich, middle and poor. In the analysis with 15 lags included the difference is strongly significant in the rich and poor countries (p-value of 0.00), whereas it is significant at the 10% level in the middle income countries (p-value of 0.061). Figure 5 displays the p-values in the three income groups for different lag lengths. In most cases the difference is strongly significant, especially for the poor countries. From this we conclude that the world food price and exchange rate should be entered separately in the regression.

Figure 5: P values of tests of the difference in the world food price pass through and the exchange rate pass through for rich, middle income and poor countries

Additional Regression Results

Figure 6: P values of tests of the difference in the long run pass through between the three income groups

In this appendix we discuss five additional fixed effects regression results. First, figure 6 displays the p-values of the difference of long run pass through in the rich, poor and middle income groups for the estimates with different lag length. The difference in long run pass through in rich and middle and in rich and poor is strongly significant, whereas the difference between middle and poor is not significant for almost all lag lengths. Second, figure 7 shows the p-values of the deviation of the long run pass through in the different continents from the average long run pass through. These p-values are based upon a pooled regression with different coefficients on the regressors (the lagged world food prices) for the three income groups and different coefficients for one of the continents. We repeat this exercise for each of the continents and display the p-values of the significance of the sum of the continent-specific coefficients. It is clear that only the African dummy is significantly different from zero for different lag lengths. Third, figure 8 displays the significance of the long run pass through deviation in the high volatility period (April 2007 to February 2011) from the rest of the sample period for the 3 different income groups. We see that in the rich and middle income countries the difference in long run pass through is strongly significant, whereas in the poor countries the difference is not significant, also not if we split up the poor countries into African and non-African.

Figure 7: P values of tests of a significantly different long run pass through in the different continents

Figure 8: P values of tests of the difference in the long run pass through in high volatility and normal periods

Fourth, tables 4 and 5 show the full estimation results of the baseline regressions underlying the long run pass throughs in column 1 of table **Error! Reference source not found.**. Fifth and finally, tables 6 and 7 display the full estimation results of the regressions in column 2 of table

Error! Reference source not found. allowing for excess volatility between 2007 and 2011. Only the coefficients on the world food price index are displayed.

Table 4: Complete regression results of calculation of long run pass through

	(1) rich		(2) middle income		(3) poor	
$\Delta \ln FX_t$	-0.0086**	(0.0043)	0.025***	(0.0042)	0.029***	(0.0081)
$\Delta \ln FX_{t-1}$	0.0053	(0.0044)	0.036***	(0.0043)	0.052***	(0.0082)
$\Delta \ln FX_{t-2}$	0.011***	(0.0044)	0.036***	(0.0043)	0.059***	(0.0081)
$\Delta \ln FX_{t-3}$	0.0094**	(0.0043)	0.046***	(0.0043)	0.038***	(0.0080)
$\Delta \ln FX_{t-4}$	-0.00017	(0.0043)	0.018***	(0.0042)	0.032***	(0.0080)
$\Delta \ln FX_{t-5}$	0.0071*	(0.0043)	0.024***	(0.0043)	0.018**	(0.0080)
$\Delta \ln FX_{t-6}$	0.0067	(0.0043)	0.0088**	(0.0043)	0.032***	(0.0080)
$\Delta \ln FX_{t-7}$	0.011***	(0.0043)	0.016***	(0.0042)	0.030***	(0.0079)
$\Delta \ln FX_{t-8}$	-0.00013	(0.0043)	0.015***	(0.0042)	0.029***	(0.0079)
$\Delta \ln FX_{t-9}$	0.015***	(0.0042)	0.014***	(0.0042)	0.010	(0.0079)
$\Delta \ln FX_{t-10}$	-0.00100	(0.0042)	0.012***	(0.0042)	0.020***	(0.0079)
$\Delta \ln FX_{t-11}$	0.0098**	(0.0042)	0.016***	(0.0042)	0.019**	(0.0078)
$\Delta \ln FX_{t-12}$	-0.0025	(0.0042)	0.0095**	(0.0042)	0.016**	(0.0078)
$\Delta \ln FX_{t-13}$	0.0024	(0.0043)	0.014***	(0.0042)	0.013*	(0.0078)
$\Delta \ln FX_{t-14}$	0.0034	(0.0042)	0.0050	(0.0042)	0.026***	(0.0077)
$\Delta \ln FX_{t-15}$	0.0080*	(0.0041)	0.0100**	(0.0042)	0.0061	(0.0077)
$\Delta \ln WFPI_t$	-0.0030	(0.0034)	0.016***	(0.0044)	0.016*	(0.0087)
$\Delta \ln WFPI_{t-1}$	0.0100***	(0.0036)	0.020***	(0.0045)	0.040***	(0.0087)
$\Delta \ln WFPI_{t-2}$	0.014***	(0.0036)	0.026***	(0.0046)	0.050***	(0.0090)
$\Delta \ln WFPI_{t-3}$	0.0061*	(0.0036)	0.021***	(0.0046)	0.021**	(0.0089)
$\Delta \ln WFPI_{t-4}$	0.0035	(0.0035)	0.031***	(0.0045)	0.022**	(0.0089)
$\Delta \ln WFPI_{t-5}$	0.015***	(0.0035)	0.024***	(0.0045)	0.022**	(0.0088)
$\Delta \ln WFPI_{t-6}$	0.0088**	(0.0036)	0.011**	(0.0046)	-0.0018	(0.0090)
$\Delta \ln WFPI_{t-7}$	0.0090**	(0.0036)	0.0086*	(0.0046)	0.030***	(0.0090)
$\Delta \ln WFPI_{t-8}$	0.013***	(0.0037)	0.013***	(0.0047)	0.032***	(0.0091)
$\Delta \ln WFPI_{t-9}$	0.0023	(0.0037)	0.013***	(0.0047)	-0.0055	(0.0091)
$\Delta \ln WFPI_{t-10}$	0.0051	(0.0037)	0.0080*	(0.0047)	0.0019	(0.0090)
$\Delta \ln WFPI_{t-11}$	0.015***	(0.0037)	0.023***	(0.0047)	0.011	(0.0091)
$\Delta \ln WFPI_{t-12}$	-0.0013	(0.0038)	0.0067	(0.0048)	0.021**	(0.0091)
$\Delta \ln WFPI_{t-13}$	0.0035	(0.0038)	0.013***	(0.0048)	0.0065	(0.0092)
$\Delta \ln WFPI_{t-14}$	0.0098***	(0.0037)	0.017***	(0.0047)	0.024***	(0.0091)
$\Delta \ln WFPI_{t-15}$	0.0087**	(0.0036)	0.0045	(0.0047)	-0.00033	(0.0091)
Observations	4981		8384		5360	
No of countries	36		68		43	
χ^2	397.5		916.3		392.5	

Standard errors in parentheses

Fixed effects regression with heteroskedastic panel and AR1 error structure
*p<0.10,**p<0.05,***p<0.01

Table 5: Complete regression results of calculation of long run pass through

	(1) Poor Africa		(2) Poor Non-Africa	
$\Delta \ln FX_t$	0.024***	(0.0092)	0.047**	(0.021)
$\Delta \ln FX_{t-1}$	0.046***	(0.0092)	0.075***	(0.021)
$\Delta \ln FX_{t-2}$	0.055***	(0.0091)	0.081***	(0.020)
$\Delta \ln FX_{t-3}$	0.037***	(0.0090)	0.035*	(0.020)
$\Delta \ln FX_{t-4}$	0.034***	(0.0090)	0.011	(0.020)
$\Delta \ln FX_{t-5}$	0.020**	(0.0089)	-0.0064	(0.020)
$\Delta \ln FX_{t-6}$	0.038***	(0.0089)	0.00083	(0.020)
$\Delta \ln FX_{t-7}$	0.031***	(0.0089)	0.027	(0.020)
$\Delta \ln FX_{t-8}$	0.036***	(0.0089)	0.0013	(0.020)
$\Delta \ln FX_{t-9}$	0.012	(0.0089)	0.0072	(0.020)
$\Delta \ln FX_{t-10}$	0.022**	(0.0088)	0.014	(0.020)
$\Delta \ln FX_{t-11}$	0.013	(0.0088)	0.046**	(0.020)
$\Delta \ln FX_{t-12}$	0.013	(0.0087)	0.037*	(0.020)
$\Delta \ln FX_{t-13}$	0.0084	(0.0087)	0.052**	(0.020)
$\Delta \ln FX_{t-14}$	0.012	(0.0087)	0.11***	(0.020)
$\Delta \ln FX_{t-15}$	0.0066	(0.0087)	0.019	(0.020)
$\Delta \ln WFPI_t$	0.014	(0.011)	0.024*	(0.014)
$\Delta \ln WFPI_{t-1}$	0.022*	(0.011)	0.075***	(0.014)
$\Delta \ln WFPI_{t-2}$	0.030**	(0.012)	0.086***	(0.015)
$\Delta \ln WFPI_{t-3}$	0.021*	(0.012)	0.024*	(0.015)
$\Delta \ln WFPI_{t-4}$	0.020*	(0.012)	0.027*	(0.015)
$\Delta \ln WFPI_{t-5}$	0.0063	(0.012)	-0.019	(0.015)
$\Delta \ln WFPI_{t-6}$	0.0073	(0.012)	-0.019	(0.015)
$\Delta \ln WFPI_{t-7}$	0.032***	(0.012)	0.031**	(0.015)
$\Delta \ln WFPI_{t-8}$	0.021*	(0.012)	0.057***	(0.015)
$\Delta \ln WFPI_{t-9}$	-0.013	(0.012)	0.011	(0.015)
$\Delta \ln WFPI_{t-10}$	-0.0013	(0.012)	0.012	(0.015)
$\Delta \ln WFPI_{t-11}$	0.012	(0.012)	0.010	(0.015)
$\Delta \ln WFPI_{t-12}$	0.036***	(0.012)	-0.0026	(0.015)
$\Delta \ln WFPI_{t-13}$	-0.0029	(0.012)	0.023	(0.015)
$\Delta \ln WFPI_{t-14}$	0.015	(0.012)	0.043***	(0.015)
$\Delta \ln WFPI_{t-15}$	0.0067	(0.012)	-0.011	(0.015)
Observations	3652		1708	
No of countries	29		14	
χ^2	299.8		163.8	

Standard errors in parentheses

Fixed effects regression with heteroskedastic panel and AR1 error structure
*$p<0.10$, **$p<0.05$, ***$p<0.01$

Table 6: Complete regression results of calculation of long run pass through with excess volatility

	(1) Rich		(2) Middle income		(3) Poor	
$\Delta\ln WFPI_t$	-0.017***	(0.0062)	0.0027	(0.0080)	-0.0012	(0.017)
$\Delta\ln WFPI_{t-1}$	-0.0098	(0.0062)	0.021**	(0.0083)	0.036**	(0.018)
$\Delta\ln WFPI_{t-2}$	0.0064	(0.0062)	0.025***	(0.0083)	0.056***	(0.018)
$\Delta\ln WFPI_{t-3}$	0.0092	(0.0060)	0.026***	(0.0083)	0.0032	(0.018)
$\Delta\ln WFPI_{t-4}$	-0.0026	(0.0059)	0.026***	(0.0082)	0.014	(0.018)
$\Delta\ln WFPI_{t-5}$	0.013**	(0.0057)	0.017**	(0.0079)	0.030*	(0.017)
$\Delta\ln WFPI_{t-6}$	0.013**	(0.0061)	0.0069	(0.0082)	-0.016	(0.017)
$\Delta\ln WFPI_{t-7}$	0.0100	(0.0061)	0.0068	(0.0081)	0.039**	(0.018)
$\Delta\ln WFPI_{t-8}$	0.0057	(0.0066)	0.0052	(0.0086)	0.040**	(0.018)
$\Delta\ln WFPI_{t-9}$	-0.018***	(0.0067)	0.0013	(0.0087)	-0.0076	(0.018)
$\Delta\ln WFPI_{t-10}$	-0.0024	(0.0065)	-0.012	(0.0085)	-0.012	(0.018)
$\Delta\ln WFPI_{t-11}$	0.0014	(0.0066)	-0.00046	(0.0087)	-0.012	(0.018)
$\Delta\ln WFPI_{t-12}$	-0.010	(0.0066)	-0.00092	(0.0086)	0.0096	(0.018)
$\Delta\ln WFPI_{t-13}$	0.021***	(0.0065)	0.028***	(0.0083)	-0.0061	(0.017)
$\Delta\ln WFPI_{t-14}$	0.021***	(0.0064)	0.028***	(0.0080)	0.030*	(0.017)
$\Delta\ln WFPI_{t-15}$	0.0031	(0.0066)	0.0058	(0.0082)	0.0030	(0.017)
$\Delta\ln WFPI_t$	0.015*	(0.0080)	0.019*	(0.010)	0.027	(0.021)
$\Delta\ln WFPI_{t-1}$	0.016*	(0.0085)	-0.016	(0.011)	-0.0021	(0.022)
$\Delta\ln WFPI_{t-2}$	0.019**	(0.0085)	0.0051	(0.011)	-0.016	(0.022)
$\Delta\ln WFPI_{t-3}$	-0.0072	(0.0081)	-0.011	(0.011)	0.016	(0.022)
$\Delta\ln WFPI_{t-4}$	0.014*	(0.0080)	0.010	(0.010)	0.013	(0.022)
$\Delta\ln WFPI_{t-5}$	-0.000014	(0.0079)	0.011	(0.010)	-0.028	(0.021)
$\Delta\ln WFPI_{t-6}$	-0.0063	(0.0082)	0.0033	(0.010)	0.027	(0.021)
$\Delta\ln WFPI_{t-7}$	-0.0029	(0.0081)	0.0063	(0.010)	-0.023	(0.021)
$\Delta\ln WFPI_{t-8}$	0.015*	(0.0084)	0.0097	(0.011)	-0.0059	(0.022)
$\Delta\ln WFPI_{t-9}$	0.027***	(0.0084)	0.021*	(0.011)	0.00092	(0.022)
$\Delta\ln WFPI_{t-10}$	0.0027	(0.0083)	0.026**	(0.011)	0.023	(0.021)
$\Delta\ln WFPI_{t-11}$	0.014*	(0.0085)	0.035***	(0.011)	0.026	(0.022)
$\Delta\ln WFPI_{t-12}$	0.020**	(0.0086)	0.013	(0.011)	0.013	(0.021)
$\Delta\ln WFPI_{t-13}$	-0.027***	(0.0087)	-0.023**	(0.011)	0.015	(0.021)
$\Delta\ln WFPI_{t-14}$	-0.013	(0.0086)	-0.015	(0.010)	-0.014	(0.021)
$\Delta\ln WFPI_{t-15}$	0.013	(0.0084)	0.0029	(0.010)	-0.0064	(0.020)
Observations	4981		8384		5360	
No of countries	36		68		43	
χ^2	547.0		1036.0		458.0	

Standard errors in parentheses

Fixed effects regression with heteroskedastic panel and AR1 error structure
HV is a dummy for the high volatility period, from April 2007 to February 2011
**p*<0.10, ***p*<0.05, ****p*<0.01

Table 7: Complete regression results of calculation of long run pass through with excess volatility

	(1) Poor Africa		(2) Poor Non-Africa	
$\Delta \ln WFPI_t$	-0.00035	(0.022)	-0.00084	(0.027)
$\Delta \ln WFPI_{t-1}$	0.030	(0.023)	0.046	(0.030)
$\Delta \ln WFPI_{t-2}$	0.050**	(0.023)	0.059**	(0.030)
$\Delta \ln WFPI_{t-3}$	-0.0046	(0.024)	0.0062	(0.030)
$\Delta \ln WFPI_{t-4}$	0.014	(0.024)	0.022	(0.030)
$\Delta \ln WFPI_{t-5}$	0.029	(0.023)	0.042	(0.029)
$\Delta \ln WFPI_{t-6}$	-0.022	(0.023)	0.013	(0.029)
$\Delta \ln WFPI_{t-7}$	0.040*	(0.023)	0.053*	(0.029)
$\Delta \ln WFPI_{t-8}$	0.029	(0.024)	0.056*	(0.031)
$\Delta \ln WFPI_{t-9}$	-0.016	(0.024)	0.0038	(0.031)
$\Delta \ln WFPI_{t-10}$	-0.016	(0.023)	-0.0088	(0.030)
$\Delta \ln WFPI_{t-11}$	-0.012	(0.023)	-0.015	(0.030)
$\Delta \ln WFPI_{t-12}$	0.031	(0.023)	-0.019	(0.030)
$\Delta \ln WFPI_{t-13}$	-0.027	(0.022)	0.026	(0.029)
$\Delta \ln WFPI_{t-14}$	0.025	(0.022)	0.051*	(0.028)
$\Delta \ln WFPI_{t-15}$	0.0049	(0.022)	0.0030	(0.027)
$\Delta \ln WFPI_t$	0.028	(0.027)	0.034	(0.034)
$\Delta \ln WFPI_{t-1}$	-0.018	(0.029)	0.026	(0.036)
$\Delta \ln WFPI_{t-2}$	-0.043	(0.029)	0.037	(0.036)
$\Delta \ln WFPI_{t-3}$	0.028	(0.029)	0.014	(0.036)
$\Delta \ln WFPI_{t-4}$	0.0030	(0.029)	0.023	(0.036)
$\Delta \ln WFPI_{t-5}$	-0.0048	(0.028)	-0.075**	(0.035)
$\Delta \ln WFPI_{t-6}$	0.041	(0.028)	-0.020	(0.036)
$\Delta \ln WFPI_{t-7}$	-0.020	(0.028)	-0.034	(0.036)
$\Delta \ln WFPI_{t-8}$	-0.0060	(0.029)	0.0062	(0.036)
$\Delta \ln WFPI_{t-9}$	0.0023	(0.029)	0.0091	(0.036)
$\Delta \ln WFPI_{t-10}$	0.030	(0.028)	0.026	(0.036)
$\Delta \ln WFPI_{t-11}$	0.025	(0.028)	0.026	(0.036)
$\Delta \ln WFPI_{t-12}$	0.00052	(0.028)	0.033	(0.036)
$\Delta \ln WFPI_{t-13}$	0.031	(0.028)	-0.0067	(0.036)
$\Delta \ln WFPI_{t-14}$	-0.022	(0.027)	-0.012	(0.035)
$\Delta \ln WFPI_{t-15}$	-0.0061	(0.027)	-0.0083	(0.034)
Observations	3652		1708	
No of countries	29		14	
χ^2	373.2		193.2	

Standard errors in parentheses

Fixed effects regression with heteroskedastic panel and AR1 error structure
HV is a dummy for the high volatility period, from April 2007 to February 2011
*$p<0.10$, **$p<0.05$, ***$p<0.01$

Annex D GTAP Sector Aggregation

Annex Table D.1: Detailed region aggregation in GTAP

Region Code	Region Details
HincPacific	Australia, New Zealand
HincAsia	Japan, Korea, Taiwan, Singapore, Hong Kong
HincAmerica	USA, Canada
HincEurope	European Union, Switzerland, Norway, Iceland
EastAsia	China, Mongolia, rest of East Asia
SEAsia	South East Asia
SouthAsia	South Asia
Latin America	Latin America
MENA	Middle East, North Africa
SSA	Sub-Saharan Africa (excl South Africa)
ROW	Rest of the World

Annex Table D.2 Detailed sector aggregation in GTAP		
Sectors	Sector Description	Detailed Commodity Components
PrimFood	Primary Food	Paddy rice; Wheat; Cereal grains nec; Vegetables, fruit, nuts; Oil seeds; Sugar cane, sugar beet; Crop nec; Cattle,sheep,goats, horses; Animal products nec; Raw milk.
Otheragr	Other Agricultual Products	Plant-based fibers; Wool, silk-worm cocoons.
Extraction	Mining and Extraction	Forestry; Fishing; Coal; Oil; Gas; Minerals nec.
ProcFood	Processed Food	Meat: cattle,sheep,goats,horse; Meat products nec; Vegetable oils and fats; Dairy products; Processed rice; Sugar; Food products nec; Beverages and tobacco products.
TextWapp	Textiles and Clothing	Textiles; Wearing apparel.
LightMnfc	Light Manufacturing	Leather products; Wood products; Paper products, publishing; Metal products; Motor vehicles and parts; Transport equipment nec; Manufactures nec.
HeavyMnfc	Heavy Manufacturing	Petroleum, coal products; Chemical,rubber, plastic prods; Mineral products nec; Ferrous metals; Metals nec; Electronic equipment; Machinery and equipment nec.
Margins	Trade sectors	Trade.
OthServices	Other Services	Electricity; Gas manufacture, distribution; Water; Construction; Transport nec; Sea transport; Airt ransport; Communication; Financial servicesnec; Insurance; Business

	services nec; Recreation and other services; PubAdmin/Defence/Health/Educat; Dwellings.

Supplementary Materials:

This section includes the actual text of the Supplementary Materials, which can include any or all of the preceding items, and figure captions and tables that can easily be incorporated into one supplementary material file. Please edit the list above as appropriate and include it at the end of your main paper. If there are additional files that cannot be easily accommodates (e.g., movies or large tables), please include captions here.

Materials and Methods: Can include the Materials and Methods here. Additional references should be cited here and included in the main reference list.

Any Additional Author notes: For example, author contributions or a list of group authors.