Regional Food Price Inflation Transmission

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ABSTRACT

In a context of high and more volatile food prices, understanding to what extent and speed food price changes on international markets are transmitted to consumers is key in assessing the vulnerability of households to price shocks. This is an important dimension of food security appraisal, especially for developing countries, where consumers tend to spend a higher proportion of their income on food items.

The aim of this paper is to provide measures of the transmission of price changes from international markets to consumers, at regional and sub-regional levels. This analysis, based on FAO’s new regional consumer food price indices, is useful in establishing typologies of regions and sub-regions with respect to their levels and speed of price transmission. Regional estimates of food inflation transmission can also be used to predict consumer-level impacts of international price shocks for different regions of the world, contributing to improve the information basis on which to base policy mitigation actions and to increase the efficiency of these actions by focusing on the regions or sub-regions likely to suffer the most.

Keywords: Food price inflation transmission; Regional consumer food prices; International food prices

The views expressed in this paper are those of the author and do not necessarily reflect those of the FAO or of the governments of its Member countries.
1. Purpose and scope

The purpose of this paper is to provide statistical evidence on the extent and speed of the transmission of price fluctuations on international food commodity markets to consumers for a set of regions and sub-regions of the world.

In this paper, we estimate price transmission using monthly data on regional consumer food prices and international food prices. On the basis of these estimates, the regions and sub-regions most exposed to international shocks are identified, and indications on the driving factors explaining cross-regional differences, such as market structures or policy mitigation measures, are also provided.

This analysis is useful in many regards: first, to our knowledge, consistent and up-to-date measures of food inflation transmission at regional level seldom exist in the recent economic and econometric literature; second, the determination of a typology of regions with respect to their exposure to shocks on international food commodity markets contributes to improve the information basis required to design food security policies adapted to specific regional situations; third, the estimated functional relationships linking food consumer prices and international commodity prices can be used to forecast consumer impacts of price shocks occurring on international markets, facilitating the implementation of timely policy responses.

The remaining sections of this paper are organized as follows: the second section describes the major determinants of food price transmission; the third section presents the main econometric models that can be used to estimate food price transmission and the approach adopted in this paper. The fourth section presents the results of the estimations for selected regions, underlining the factors explaining regional differences; the fifth and final section concludes and identifies possible improvements to the methodology. Annexes provide details on the data used and on the results of the transmission estimations and regressions.

2. The determinants of the transmission of food inflation from international markets to consumers

In the context of this paper, we define food price inflation transmission as the percentage change in food consumer prices resulting from a given change in the international market prices of the main basic food commodities. Even if we propose to directly measure the impacts of price shocks at the upstream or producer level on downstream consumer prices, bypassing all the intermediate steps in the value-chain, it is necessary to understand what are the major factors determining transmission and how transmission is amplified or mitigated along the chain.

A The main transmission channels

A.1 Commodity imports

International food prices are first related to domestic food prices through commodity imports: directly, through purchases of imported goods from wholesalers on international output markets and indirectly, through purchases of imported agricultural inputs from producers on international markets (seed, feed, raw commodities, etc.), which affect production costs (Figure 1).
A.2 Spatial arbitrage or the law of one price

When producers can arbitrate freely between selling their products on the domestic market or abroad, domestic producer prices and international market prices will tend to converge: domestic producers will sell their products abroad if the international price is higher than the domestic price, reducing the supply on the domestic market and therefore generating upward pressures on domestic prices. This process continues until domestic producer prices are equal to international prices, net of transportation costs. This model is valid for homogeneous commodities traded in markets undistorted by export restrictions, trade barriers or price support policies (efficient markets). Ninot (2010) describes in detail the theoretical framework underpinning this concept. The law of one price is useful to understand why prices tend to move in similar directions, especially when price changes on international markets reach certain thresholds. It may also explain the existence of a significant correlation between domestic and international prices in a country or region which is little dependent on food imports.

B Factors mitigating or amplifying transmission

B.1 Market power

The extent to which shocks on international markets are transmitted along value-chains to final consumers depends on the capacity of each market actor to pass-on price changes to their respective clients. This in-turn depends on the structure of the markets and of the distribution chains, the pricing strategies of each actor and their respective market power: for example, in response to a price increase on international markets, when wholesalers are in a dominant position with respect to producers, the latter will tend to absorb some of the price rise to avoid loosing market shares; conversly, price shocks will be more widely transmitted to wholesalers if producers are in a more favourable situation. In this situation, they may even tend to pass-on more completely to wholesalers price rises than price decreases. The existence of assymetries in the price transmission process and their empirical implications are discussed in detail in Vavra and Goodwin (2005). The final transmission to consumers is the result of these complex market relationships at each level of the chain.

B.2 Transport and transaction costs

Transport costs associated with the shipment of imported commodities within the country’s borders have to be distinguished from those incurred to ship commodities, domestically produced or not, to domestic consumption hubs. The former affect unambigiously the demand for imports, and therefore the correlation between domestic and international prices. Regarding the latter, the final impact is less clear-cut: on the one hand, high domestic transport costs or, similarly, the lack of appropriate transport infrastructures, limits the ability of market intermediaries to ship at reasonable costs domestically produced commodities to the main consumption hubs. For a given country or region, this may increase its reliance on food imports and its exposure to international price shocks. On the other hand, if production areas are close to consumption hubs and the latter are situated far from the country borders, this may benefit domestic products.
Transport costs and the transaction costs incurred to import, market and distribute food commodities are often cited as one of the main sources of non-linearities in the price transmission process (Conforti, 2004). Indeed, adjustments may be triggered by a rise or fall in the international price of a given commodity beyond the limits within which it had been evolving since then: for example the fact that, for a given country, commodities on international markets start trading significantly and persistently higher than domestic prices (net of transport and transaction costs) is likely to trigger sudden reactions from importers (reduction of import demand and/or change in the geographical pattern of imports), producers (alignment of domestic prices to international prices, re-orientation of production towards exports), consumers (reduction in the demand for certain products, substitutions) and policymakers.

B.3 Exchange rates

Exchange rate fluctuations can absorb or amplify price changes on international markets, as the national currency appreciates or depreciates vis-à-vis the currency in which the commodities are traded.

B.4 Policy interventions

A wide range of policy interventions affect the degree of correlation between international market prices and domestic consumers prices. An extensive list and detailed description of these instruments has been prepared in the framework of an FAO-led project on the Monitoring of African and Agricultural Policies (MAFAP). The main policy interventions relevant for price transmission analysis are listed and shortly described below:

**Import tariffs** By reducing the relative price competitiveness of foreign products, they contribute to shelter domestic producers from foreign competition. Higher import tariffs translate into lower price transmission to the extent that tariffs reduce import demand.

**Export tariffs** Their objective is generally to ensure that domestic producers sell a higher or a minimal share of their products on domestic markets. Export tariffs may be temporarily raised to reduce tensions on domestic prices in situations where prices on international markets are high (several countries adopted this approach during the 2007-2008 food price crisis). These policies may lead to adverse effects because they contribute to increase the uncertainty in global supply, especially if the country is a significant player in the market, and may in fact contribute to exacerbate price tensions.

**Input subsidies** They can take different forms, including direct subsidies on the amounts of inputs purchased by the farm, tax deductions, subsidies based on quantities produced or area harvested, etc. Their objective is to support the price competitiveness of domestic products on domestic and international markets by reducing production costs and allowing farmers to sell their products at a lower price than they would otherwise need to in a competitive environment. Similarly to import tariffs, all things being held equal, they contribute to increase the relative price of imported products, reduce import demand and, therefore, potential price transmission between international and domestic prices.

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1 The document is available at: http://www.fao.org/mafap/en/
*Production subsidies* Subsidies based on quantities produced, area harvested, total land area, etc. affect the net revenue of the farm and therefore have similar impacts on import demand and price transmission than input subsidies.

**Figure 1: Transmission of shocks to domestic consumers**

3. Measuring Food Price Inflation Transmission

A Succinct overview of the recent literature

There is a wide body of literature on the pass-through of international food prices to domestic prices for specific commodities and countries. A review of this literature is provided in Ferrucci *et al* (2010), with a specific focus on EU countries and the USA. Other recent references are Ninot (2010) and Aguero (2007), the focus of the former being Sub-Saharan African countries.

The analysis of the relationship between price fluctuations on international food commodity markets and average food consumer price inflation seems to have been a less popular topic of study. One of the reasons for that may be that policy interventions needed to mitigate the impacts of international market shocks on domestic markets are generally implemented at the level of individual commodity markets. However, with prices of agricultural commodities persistently trading at high levels, interest on this topic has been spurred by the concern that the actual pass-through to consumer food price inflation might become significant enough to affect core inflation, through second round effects, as indicated by Jalil and Tamayo Zea (2011).

Among the recent papers on this topic, Hyeon-seung Huh *et al* (2012), looked into the international transmission of food prices and volatilities using a panel analysis for a set of countries in the Asia-Pacific region. Their analysis, based on a vector auto-regressive (VAR) framework, allows to distinguish the impact of regional price shocks (measured by regional food inflation rates) from shocks on international markets (measured by the FAO Food Price Index). One of the main findings of the study is that domestic food prices react essentially to regional price shocks, while world price shocks contribute virtually none to explaining the variation in price. This result has to be nuanced by the fact that the authors use two different
types of price measures at the world and regional levels: the former is a composite price index for a set of commodities traded on international markets while the latter is a simple average of country Consumer Price Indices (CPIs), which tend to be more closely correlated to country CPIs. A different result might have emerged if a regional commodity price index had been used instead of a regional CPI.

In another recent study, Jalil and Tamayo Zea (2011) provide estimations of transmission elasticities between international commodity prices, food inflation and core inflation for a set of Latin American countries. Vector error correction models (VECMs) are used to model the following variables: an international food price index (the FAO Food Price Index is used as a benchmark), an activity variable (GDP), food consumer prices (Food CPI), a core inflation index and monetary variables (central bank reference interest rate, exchange rates). The authors find that in almost all the countries of the sample local food prices react in a limited way to shocks in international food prices and that these responses differ significantly across countries both in amplitude (highest response to a unit shock ranging from 0.06 to 0.17) and timing (one to six quarters).

Ferrucci et al. (2010) provide measures of pass-through of international price shocks, at the commodity level and for a basket of commodities, to the Harmonized Food Consumer Price Index (HICP) in the euro area. Several deviations from the linear model are tested, among which asymmetric price transmission. The authors find incomplete pass-through in all cases, with the cumulated impact after 6 quarters ranging between 30% and 50% depending on the models tested. At the level of individual commodities, estimated transmission is the highest for diary products (0.6) and the lowest for sugar (0.02).

**B Econometric strategies to estimate price transmission**

**B.1 Estimating price transmission equations**

The first step in measuring price transmission consists in defining an estimable functional relationship linking regional food consumer prices to international food prices.

As in any time-series econometric analysis, care has to be taken to ensure that the variables included in the analysis are stationary, i.e. that they do not display any kind of trend. The coefficients of the regression between non-stationary (or integrated) time-series may indeed reflect the common trends and not the true underlying correlation between the two variables. This problem of “spurious” regression has been well described in the literature, especially by Granger and Newbold (1973). Several techniques exist to detect non-stationarity, such as the well-known Dickey-Fuller and Phillips-Perron tests for unit roots. In the presence of non-stationarity, which is a characteristic shared by many macroeconomic time-series, it is necessary to de-trend the variables, for example by working on the first-differences or growth rates of the series, and to incorporate them in an appropriate econometric framework, such as autoregressive models (AR) or Error-Correction Models (ECM). These models are shortly described and discussed here in the context of price transmission:

Let \( P_t \) be the regional consumer food price index for a given country measured in \( t \), \( P^*_t \) a composite international commodity price index, such as the FAO Food Price Index, \( X_t \) a set
of explanatory and exogenous variables (GDP, agricultural production, food import dependency ratio, exchange rate, etc.) and \( \varepsilon_t \) a random error term. Variables in low-cases represent natural logarithms, and growth rates or first log-differences when dotted. Vectors are in bold.

**Augmented Auto-Regressive (AR)** Food inflation transmission is estimated by regressing changes in consumer food prices on its past and on present and past changes in international prices and in the set of exogenous variables:

\[
p_t = c + \sum_{i=1}^{p} \alpha_i \hat{p}_{t-i} + \sum_{j=0}^{k} \beta_j \hat{p}_{t-j}^* + \sum_{l=0}^{m} \gamma_l \hat{x}_{t-l} + \varepsilon_t
\]

**Error Correction Models (ECM)** This approach is appropriate to model a set of co-integrated series\(^2\), if the time span is large enough to capture short-term dynamics and long-term trends and if the main explanatory variables can be included in the model. The lagged residual from the co-integrating relationship (representing the long-term or equilibrium relationship) is added to the auto-regressive component. When food prices move above (under) their estimated long-term level, a proportion of this gap is subtracted (added) to the short-term dynamics in the following period, bringing the estimation closer to its long-term or equilibrium path. \( \mu \) measures the speed at which the endogenous variable, food consumer prices, converges to its long-term path after a shock:

\[
p_t = c + \sum_{i=1}^{p} \alpha_i \hat{p}_{t-i} + \sum_{j=0}^{k} \beta_j \hat{p}_{t-j}^* + \sum_{l=0}^{m} \gamma_l \hat{x}_{t-l} + \mu [p_{t-1} - (a + \beta p_{t-1}^* + \gamma x_{t-1})] + \varepsilon_t
\]

**Non-Linear ARs or ECMs** These models may be sophisticated by the introduction of non-linearities, which in the context of price transmission estimation are mainly of two sorts: threshold effects and asymmetric transmission. Threshold models may be used to account for the fact that the nature of the relationship linking \( P_t \) to \( P_t^* \) may evolve over time: for example, price dynamics in periods of high volatility may differ from those prevailing when volatility is lower; the introduction of new regulations, policies, etc. may also definitively modify the nature of the relationship linking macroeconomic time series such as food consumer prices and international food commodity prices (structural breaks); the existence of transport and transaction costs, as previously explained, contribute to create and amplify threshold effects. Different models can be used depending on the nature of the threshold: existence or not of a structural break, extent of the knowledge on the underlying mechanism governing the change in the nature of the relationship (e.g. price volatility level), timing of the change (brutal or smooth/continuous). The example below is an AR model with a structural break in the relationship at an unknown date \( \tilde{t} \):

\(^2\) Two time series are said to be co-integrated to the order \( p \), CI(\( p \)), if each of them is integrated to the degree \( p \), I(\( p \)), and if some linear combination of these series is integrated to the order \( p-1 \). It follows that if two time-series are I(1) and if some linear combination is stationary, i.e. I(0), the two time-series are said to be co-integrated and can be modelled using an ECM.
\[ \dot{p}_t = \delta(t \leq \bar{t}) \cdot \text{AR}_1(\dot{p}, \dot{p}^*, \dot{x}) + \left(1 - \delta(t \leq \bar{t})\right) \cdot \text{AR}_2(\dot{p}, \dot{p}^*, \dot{x}) \]

Where \( \delta(t \leq \bar{t}) = 1 \) if \( t \leq \bar{t} \) and \( \delta(t \leq \bar{t}) = 0 \) otherwise and where \( \text{AR}_1(\cdot) \) and \( \text{AR}_2(\cdot) \) are linear functions of the past of \( \dot{p} \) and present and past of \( \dot{p}^* \) and \( \dot{x} \).

Another type of non-linearity arises when positive price shocks on international markets are not passed on to consumer prices in a similar way than negative ones. To account for the possibility of asymmetries in the price transmission process, a similar model than the one presented above can be estimated, the only difference being the nature of the rule governing the shift from one transmission process to the other:

\[ \dot{p}_t = \delta(\dot{p}^*_t \leq 0) \cdot \text{AR}_1(\dot{p}, \dot{p}^*, \dot{x}) + \left(1 - \delta(\dot{p}^*_t \leq 0)\right) \cdot \text{AR}_2(\dot{p}, \dot{p}^*, \dot{x}) \]

**Vector ARs or ECMs** When the causality between explained and explanatory variables goes in both directions, a multi-dimensional version of these models can be used, where each variable is included both as endogenous and exogenous variable. A bivariate AR for \( \dot{p} \) and \( \dot{p}^* \) is defined by:

\[
\begin{pmatrix} \dot{p} \\ \dot{p}^* \end{pmatrix}_t = \begin{pmatrix} c \\ \alpha \end{pmatrix} + \sum_{i=1}^{p} A_i \begin{pmatrix} \dot{p} \\ \dot{p}^* \end{pmatrix}_{t-i} + \sum_{i=0}^{m} B_i \dot{x}_{t-i} + \varepsilon_t
\]

Where \( c = \begin{pmatrix} c \\ c^* \end{pmatrix} \), \( A_i = \begin{pmatrix} \alpha_i \\ \beta_i^* \end{pmatrix} \), \( B_i = \begin{pmatrix} Y_i \\ Y_i^* \end{pmatrix} \) and \( \varepsilon_t = \begin{pmatrix} \varepsilon \\ \varepsilon^* \end{pmatrix} \), the coefficients with a star are those of the regression of \( \dot{p}^* \) on \( \dot{p} \).

**B.2 Measuring price transmission using Impulse Response Functions**

Food price inflation transmission is defined here as the percentage change in food consumer prices resulting from a given change in the international market prices of the main basic food commodities, everything else being held equal.

More precisely, our objective is to quantify the impact of a shock in international food prices occurring in \( t \), i.e. \( \dot{p}^*_t = s \), on food consumer prices in \( t, t+1, \ldots, t+h, \ldots, t+H \). Impulse Response Functions (IRFs), which measure the impact of a shock in one of the explanatory variables on the endogenous variable of a dynamic system, can be used to respond to this question. Mathematically, for a given shock \( s \) occurring in \( t \), the IRF of \( \dot{p} \) with respect to \( \dot{p}^* \) in \( t+h \) can be defined as:

\[
\text{IRF} (h) = \left. \frac{\partial \dot{p}_{t+h}}{\partial \dot{p}^*_t} \right|_{\dot{p}^*_t = s}
\]

Cumulated IRFs are defined as:

\[
\text{IRF}_{\text{cum}}(H) = \sum_{h=0}^{H} \text{IRF}(h)
\]

\[
\text{IRF}_{\text{cum}}(0) = \text{IRF}(0) \] is the contemporaneous impact of the shock and \( \lim_{H \to \infty} \text{IRF}_{\text{cum}}(H) \) the long-term or total impact.
Price transmission can be approached by a set of measures, among which: the maximum impact of the shock and its associate timing, the short-term impact, the long-run impact and the time it takes for the shock to reach its full impact (response horizon). These dimensions of price transmission can all be measured using IRFs. For more details on IRFs, with a specific focus on their use in ECMs, refer to Lütkepol and Reimers (1992) and Johansen (2004).

C. Our approach

The objective of this paper is to estimate the transmission of price fluctuations from international markets to consumers, for different regions and sub-regions of the world. The data used and the estimation strategy adopted here are shortly described in this section.

C.1 The data

In this study, monthly data has been used for the computations to appropriately capture market shocks that tend by essence to occur at a high frequency - weekly or even daily - as it is the case on markets where commodities or products are traded on a daily basis. If quarterly or annual data had been used instead, shocks might have been smoothed and therefore less adequately reflected by the data. The use of monthly data compared to quarterly or annual data also allows to significantly increase the sample size from which the estimations are drawn (157 months) and therefore potentially improve the precision and accuracy of the estimates. However, using monthly data reduces the possibility to include auxiliary variables in the model, such as regional GDP estimates or other macroeconomic variables, as many of them are not available at this frequency.

The estimation framework is based on the use of two types of price series: international market prices for agricultural commodities and average consumer prices for food items, for different regions and sub-regions. The FAO Food Price Index (FPI) provides 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 2002-2004³.

The average consumer food prices at regional level are measured by FAO’s new Global and Regional Food Consumer Price Indices (CPIs) ⁴. These indices measure food inflation for a group of countries at different geographical scales: sub-regional (e.g. South America), regional (e.g. Americas) and global (world, all countries). The Global Food CPI covers approximately 145 countries worldwide and 90% of the world population. The aggregation procedure is based on the use of population weights to better reflect regional food inflation and its impacts on households. Not all regions and sub-regions have been included in the estimations, but only those which can be considered as relatively homogeneous with respect to the characteristics of their respective agricultural markets. For example, Europe has been included as one region but, within Latin America, South America and Central America have been distinguished.

³ More details on FAO’s FPI and other commodity price indices on: http://www.fao.org/worldfoodsituations/foodpricesindex/en/
⁴ More details on FAO’s Global and Regional Food CPIs on: http://www.fao.org/economic/ess/ess-economic/cpi/en/
Figure 2, which compares fluctuations in the Global Food CPI with changes in the FAO Food Price Index, tends to indicate that, since 2002, both series have moved in the same general direction, with the food CPI lagging behind fluctuations in the FPI. This is particularly noticeable for peaks and troughs, such as during the food price crisis of 2007-08, when the FPI rose sharply, with the global food CPI following the increase a few months later. It is also clear from the chart on the right-hand side, in which both series are plotted using the same scale, that volatility in the FPI is not fully transmitted to the global food CPI. Although significant differences exist between regions and sub-regions, the same general pattern can be observed. Annex 1 provides charts for each region included in this analysis.

**Figure 2: Global consumer food prices and international commodity prices (year-over-year)**

![Chart](chart.png)

Source: FAO and International Labour Organization (country food CPIs)

### C.2 Estimation Strategy

The econometric approach has been to estimate separate univariate ECMs for each of the regions investigated. When using an ECM, the cumulated IRFs have the property to converge towards the long-run elasticity $\beta$ (Johansen, 2004).

The use of vector ECMs, where international market prices and regional and global food consumer prices are both considered as endogenous and exogenous variables, has not been deemed necessary. The main reason for this choice being that the direction of the relationship, from international market prices to consumers prices, is clear given the two extremes of the value-chain to which these prices refer to. This would not be the case, for example, if the objective was to estimate price transmission between wholesale and retail prices. The use of multi-dimensional models also increases the number of parameters to estimate and reduces the degrees of freedom of the regression (over-parameterization), potentially affecting the accuracy and precision of the final estimates. For example, in a VAR with only 3 variables and 2 lags, 18 parameters have to be estimated.

In the context of this research, only linear ECMs have been estimated. Further analysis will need to be carried out in order to incorporate non-linearities in the estimation of transmission elasticities. As a prelude to such analysis, we sought here to identify possible structural breaks by implementing sequential Chow tests over 2007-2008, corresponding to
the period during which the food price crisis occurred. The date of the structural break was defined as the one for which the null hypothesis of linearity of the relationship was rejected with the highest degree of confidence. Further research on this topic should be directed at better identifying threshold effects, for example using rules to identify regime shifts (e.g. price volatility levels), and at finding ways to integrate them appropriately in the modeling framework, such as allowing for smooth transition between regimes. The main results concerning the estimations are provided in Annex 3.

IRFs and cumulated IRFs were calculated on the basis of model simulations with normal residuals. Empirical quantiles and standard error estimates resulting from these simulations were used to determine 95%-confidence bands for the IRFs. This and other approaches to determine confidence bands for IRFs are discussed in Griffiths and Lütkepol (1990). These simulations were generally based on 100 draws, as this number has been found to provide sufficient robustness in the estimates. For a couple of sub-regions with more unstable results, this number has been increased to 150.

4. Results: Overview of food price inflation transmission estimates

The empirical results confirm that the transmission of price changes from international markets to consumers is lagged and incomplete and that significant differences exist between regions of the world. Table 1 provides a synthesis of the results and Annex 2 presents charts of the impulse response functions and their respective confidence bands.

The time it takes for the impact to reach its maximum is higher in developed economies such as North America and Europe where it is attained in the 8th and 11th month respectively, than in developing regions, where the maximum impact is generally felt sooner after the initial shock, often in the 1st or 2nd month. The highest impact is also greater in developing regions, where it ranges from 0.01 in Central America to 0.05 in Eastern Africa, compared to 0.01 in North America and Europe.

The cumulated impacts are also in line with this pattern: 32 months after the initial shock, approximately 20% of the initial rise in international prices had been passed on to consumers in North America and Europe, 12-20% in Latin America, 20% and 38% respectively in South Asia and South-Eastern Asia and 25-80% in Africa. Long-run elasticities are also significantly higher in developing regions: between 0.5 and 1 in Africa, close to 0.5 in Latin America and 0.3 in North America and Europe. Ferrucci et al. (2010) find a similar long-run elasticity of 0.3 for the euro area, using a different measure for international food prices. This elasticity was found to be significantly higher (0.5) in the model allowing for asymmetries.

This difference in the timing and size of the impacts tends to confirm the importance of value-chains in delaying and absorbing upstream shocks. Developed economies, in which households tend to spend a higher share of their income on processed products than consumers in developing countries, are characterized by more extended value-chains. Price transmission is generally slower and lower in these markets, as price shocks are absorbed and delayed by the multiple market actors that process, package, ship and distribute products. The reasons determining the extent to which price changes are cushioned and delayed when
passing through value-chains, such as the existence of market power, transport costs and policy mitigation measures, have been described above.

The relative size of the impact also crucially depends on the share of imports in domestic demand (import dependency ratio), which is positively correlated to price transmission. On average, countries in North America, Europe and Latin America tend to be less reliant on imports than countries in Africa, where price transmission has been found to be higher and faster. While this result may be valid at regional and sub-regional level, it cannot be extended straightforwardly to individual countries given the significant differences existing even within sub-regions. For example, while many small central American countries are characterized by relatively high import dependency ratios (often higher than 30%, reaching 50% in the case of Costa Rica), it is less the case of Mexico, the main country of the region. The relatively low estimated transmission for Central America may therefore essentially reflect transmission patterns in Mexico, a country with a developed agricultural sector and less reliant on food imports than its southern neighbors. Evidence of a slow and low pass-through in Mexico is provided by Jalil and Tamayo Zea (2011).
Table 1: Response of regional food consumer prices to a 1% shock in the FAO Food Price Index

| Region            | North America | Europe | South America | Central America | South-Eastern Asia | Southern Asia | North Africa | Western Africa | Eastern Africa | Southern Africa |
|-------------------|---------------|--------|---------------|-----------------|--------------------|---------------|--------------|----------------|----------------|----------------|
| Highest effect (%)| 0.01          | 0.01   | 0.02          | 0.01            | 0.02               | 0.02          | 0.01         | 0.03           | 0.05           | 0.03           |
| Horizon at which highest effect occurs (month) | 8  | 11  | 1  | 2  | 2  | 1  | 7 | 7 | 2 | 13  |
| Response (%) after: |                |        |               |                 |                   |               |             |               |               |               |
| 2 months          | 0.01          | 0.01   | 0.03          | 0.01            | 0.02               | 0.03          | 0.01         | 0.03           | 0.05           | 0.0           |
| 4 months          | 0.03          | 0.02   | 0.05          | 0.04            | 0.04               | 0.03          | 0.06         | 0.11           | 0.02           |               |
| 8 months          | 0.07          | 0.06   | 0.08          | 0.07            | 0.10               | 0.06          | 0.16         | 0.21           | 0.10           |               |
| 16 months         | 0.14          | 0.13   | 0.11          | 0.12            | 0.21               | 0.08          | 0.13         | 0.33           | 0.47           | 0.28           |
| 32 months         | 0.22          | 0.19   | 0.12          | 0.20            | 0.38               | 0.20          | 0.25         | 0.60           | 0.79           | 0.54           |
| Long-term         | 0.30          | 0.27   | 0.42          | 0.47            | 0.57               | 0.54          | 0.53         | 0.90           | 1.05           | 0.64           |

Source: author’s calculations

Note: the highest effect corresponds to the highest IRF which did not include 0 in its 95% confidence interval; the responses for each horizon (2 months, 4 months, etc.) correspond to the sum up to the given horizon of the IRFs which did not include 0 in their confidence interval; the long-term elasticity is the sum of all the IRFs statistically different than 0 at the 95% threshold.
5. Conclusion

This paper presented measures of the transmission of international food prices to consumer food prices in several regions and sub-regions of the world. The results confirm the findings of previous studies, i.e. that transmission is generally incomplete and lagged, and provides new evidence of differences in speed and extent of transmission among regions. Africa is the region with the highest transmission, especially Eastern Africa, where 5% of the initial shock is passed-on to consumer prices after only 2 months and 20% after 8 months. The lowest transmission is found in North America and Europe, where close to 30% of the initial impact is passed on to consumer prices. Asia (South and South-East) and Latin America are in an intermediate situation with on the long-run around half of the shock transmitted to consumer prices.

These results are only initial estimates and further research is needed to improve the transmission measures: first, additional explanatory variables, such as activity variables (GDP), import dependency ratios and exchange rates need to be incorporated in the estimation framework. Second, assymetries and other non-linearities need to be taken into account, as several studies, such as Ferrucci et al. (2010), have demonstrated their importance in the estimation of price relationships. Third, the measure of international food prices used for the estimations would need to better reflect regional import and consumption patterns, for example by re-weighting individual commodity prices by the appropriate import shares. The aggregate FAO Food Price Index, weighted by average export shares, looses some of its relevance for price transmission analysis when it does not appropriately reflect trends in regional food import prices. Finally, correlation between regional and sub-regional price shocks could be allowed for in the regressions, for example by adopting a multi-dimensional framework (VAR, VECM) or by implementing SURE estimations (seemingly unrelated regression equations).
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ANNEXES

Annex 1: *Global consumer food prices and international food prices for several regions and sub-regions (year-over-year changes)*

The Food Consumer Price Indices (Food CPIs) for each region and sub-region presented below are compiled using country-level data provided by the International Labour Organization (http://laborsta.ilo.org/).

**Africa**

**Latin America**

**Asia**
Europe and North America

Annex 2: Impulse response functions and 95% confidence bands

The impulse response functions presented here measure the response of regional consumer food prices (Food CPIs) to a unit shock in international food prices (FAO Food Price Index). The impulse response functions and their respective 95% confidence bands have been determined by model simulations (N=100 draws) based on normal residuals.

Africa

Northern Africa

Western Africa

Eastern Africa

Southern Africa
**Latin America**

**South America**

**Central America**

**Asia**

**South-Eastern Asia**

**Southern Asia**

**Europe and North America**

**Europe**

**North America**
Annex 3: *Statistics on the estimated error-correction models*

|                | North America | Europe | South America | Central America | South-Eastern Asia | Southern Asia | North Africa | Western Africa | Eastern Africa | Southern Africa |
|----------------|---------------|--------|---------------|-----------------|-------------------|---------------|--------------|----------------|----------------|----------------|
| $\beta$        | 0.30          | 0.28   | 0.85          | 0.63            | 0.84              | 0.78          | 0.84         | 0.95           | 1.34           | 0.79            |
| $\mu$          | -0.03         | -0.03  | -0.005        | -0.03           | -0.02             | -0.02         | -0.01        | -0.05          | -0.02          | -0.02           |
| Augmented DF Test (p-value) | 0.01        | 0.06   | 0.09          | 0.02            | <0.01             | 0.28          | 0.20         | 0.01           | 0.01           | 0.05            |
| Adjusted $R^2$ | 39%           | 34%    | 45%           | 17%             | 14%               | 28%           | 18%          | 23%            | 35%            | 47%            |
| Existence of a structural break | Yes (March 2008) | No    | No            | No              | Yes (Nov. 2008)   | Yes (Jan. 2008) | No          | No             | No             | No             |

Note: The null hypothesis associated with the augmented DF test is the presence of a unit root (i.e. non-stationarity). A p-value under 0.1 means that the null hypothesis of non-stationarity can be rejected with a risk of 10%.
