Spatial and Vertical price transmission in food staples market chains in Eastern and Southern Africa: What is the evidence?

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Abstract

Over the last two decades, many governments in Eastern and Southern Africa have embarked on various market reforms to improve commodity market performance. However, the success of such market reforms depends partly on the strength of the transmission of price signals between spatially separated markets and between different levels of the value chain. Several studies have therefore examined the impact of policy measures on price transmission between spatially separated markets and between different levels of the value chain in agricultural commodity markets in the region. The primary objective of this survey is to review the available empirical evidence on the subject and to highlight directions for future research in the area. The survey generally indicates significant improvements in the methodology over the period considered, although some unresolved issues still remain. Overall, market reforms exerted positive impacts on the degree and speed of price transmission.

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1. Introduction

Studies on price transmission generally examine the nature of the relationship between price series at different levels of the supply chain, or at spatially separated markets. Given that price transmission integrates markets vertically or horizontally, such studies may provide important information on how shocks in one market are transmitted to another, reflecting the extent to which markets function efficiently. Economists have particularly been interested in the speed and degree of transmission of price shocks between markets or levels of the supply chain, since that plays a role in signaling the presence of market failures (Balcombe and Morrison, 2002).

Spatial price transmission may involve how prices between spatially separated markets in a country are related, or how domestic prices adjust to international prices. Information on both forms of spatial price transmission is quite significant for policy makers. Given that several developing countries have greatly reduced the role of state-related marketing institutions, commodity price regulation, and control of international trade, information on the degree to which world price signals are transmitted to domestic commodity markets is certainly of interest to policy makers. Similarly, integration of spatially separated markets ensures that a regional balance occurs between food-deficit and food-surplus areas. Markets that are isolated may convey inaccurate price information that might distort producer-marketing decisions and contribute to inefficient product movements. Such information is quite crucial for the formulation of intervention strategies to prevent food insecurity (Goletti and Babu, 1994).

The extent of adjustment and speed with which shocks are transmitted among producer, wholesale, and retail market prices is a significant factor reflecting the actions of market participants along the market channel. The nature and extent of adjustments to market shocks may further have significant implications for marketing margins, spread, and mark-up

pricing practices. Concerns about the rate and symmetry of price responses are normally raised if one or more sectors in the marketing channel are highly concentrated and dominated by few firms (Miller and Hayenga, 2001).

In Sub-Saharan Africa, where policy reforms have been initiated during the mid-1980s and early 1990s, such studies are particularly useful in understanding the impact of policy changes on the co-movement of prices and the transmission of price signals and information across spatially separated markets. Moreover, trade reforms from the current negotiations in the World Trade Organization (WTO) may only benefit African countries, if domestic prices adjust to changes in world market prices (Baffes and Gardner, 2003).

In view of the importance of price transmission across markets, several studies have explored the nature and degree of price transmission in particular markets. These studies have applied various econometric techniques and have highlighted several factors that influence the transmission of prices vertically and spatially. Most of the empirical studies on price transmission appear to be dominated by data availability and econometric techniques whereas the theoretical literature in most cases produces parameters that are not easily operationalized in empirical analysis. Nevertheless, these empirical studies highlight the extent to which markets are related vertically and spatially.

The objective of this paper is to present a review and synthesis of spatial and vertical price transmission of commodity markets in Eastern and Southern Africa and to highlight where major contributions lie and where the major gaps exist in the empirical literature. The first section presents a conceptual framework for both spatial and vertical price transmission. The second section focuses on the econometric techniques used in examining price transmission. Section three reviews and synthesizes the empirical evidence which is organized around the topics (i) spatial price transmission across regions, (ii) spatial price transmission across countries, and (iii) vertical price transmission along the value chain. Section four

presents a summary of the empirical evidence and highlights the research gaps in the area. The final section concludes with a discussion of the extent to which trade policy interventions may affect price transmission, and how the determinants of price transmission might affect the potential impacts of trade policy intervention.

2. Analytical framework for measuring price transmission

The goal of this section is to present a review of the concept of price transmission and to discuss the various approaches that have been employed in attempting to assess the nature and extent of price transmission in agricultural commodity markets. The review focuses on specific areas of the literature that relate to spatial and vertical price transmission.

As indicated earlier, price transmission studies generally involve empirical analyses to examine how price changes in one market are transmitted to another separated by distance, reflecting the extent of market integration, or how price changes at one level of the value chain is transmitted to another level, indicating the extent to which markets function efficiently. Earlier studies analyzing spatial price transmission or market integration relied on correlations between pairs of market prices in different regions (e.g., Lele, 1967; Stigler and Sherwin, 1985). The following type of regression model was also extensively used to study the relationship between prices in distant markets (e.g., Mundlak and Larson, 1992; Gardner and Brooks, 1994):

$$P_t^1 = \delta + \beta P_t^2 + \varepsilon_t \qquad (1)$$

where P_t^i, (i = 1,2) is the price in region i at time t for a homogenous good, δ, and β are parameters to be estimated and ε_t is a random error term. A major limitation of this modeling approach is that a statistically significant coefficient may be due to common trends in the price

pairs from factors such as population growth, inflation or climate patterns, rather than price integration. [1] Moreover, dynamic adjustment processes are completely omitted.

Given that price adjustments to shocks are generally sluggish and involve considerable time lags, Ravallion (1986) developed a dynamic model of market integration. The model posits a central market, where price is a function of prices in a number of other markets as well as a vector of seasonal and policy variables. Denoting local and central markets by the superscripts 1 and 2, respectively, this can be expressed as:

$$P_t^1 = \sum_{j=1}^{n} \alpha_j P_{t-j}^1 + \sum_{j=0}^{n} \beta_j P_{t-j}^2 + \gamma X_t + \varepsilon_t \qquad (2)$$

X_t represents an intercept, time trend, seasonal dummies, and other exogenous shifters; j is used to indicate lag lengths. Markets are then integrated in the short-run when instantaneous and full price adjustment prevails. A test for short-run integration in this model is a test of the joint hypothesis that the constant equals zero and the slope equal unity. Ravallion shows that under long-run integration, the model belongs to the class of error correction models. Timmer (1987) modified the framework in equation (2) to account for the degree of market integration, which until then had been a major concern.

Developments in time series econometrics made it a rule rather than an exception to apply cointegration techniques to Ravallion's framework in modeling relationships between prices. These developments were of significance to price transmission analysis by enabling dynamic model specification and hypothesis testing about short- and long-run behavior, as well as a consideration of the time series properties of the price data (e.g., Alderman, 1993; Badiane and Shively, 1998).

The limitation of these cointegration-based tests have been highlighted in recent studies for their neglect of transaction costs, which may inhibit price transmission across

[1] For example, Sen's (1981) assertion that food markets in Ethiopia were relatively integrated during the famine of 1972-74 was later challenged with observations that suggested correlations between prices in distant markets

spatially separated markets (Abdulai, 2000; Fackler and Goodwin, 2001; Goodwin and Piggot, 2001; Barrett and Li, 2002). Particularly in Sub-Saharan Africa, where vast distances and poor infrastructure often lead to high transaction costs, making arbitrage unprofitable and isolating markets, the neglect of transaction costs may result in misleading results. The presence of these transactions costs often leads to a "neutral band" within which prices are not linked to one another. Price equalizing arbitrage is triggered only when shocks result in a price difference that exceeds the neutral band. In a recent study, Lence and Falk (2005) demonstrate why it is possible to have cointegrated prices across markets even if such markets are not integrated in an economic sense. They argue that if, for example, two locations are characterized by similar endowments for a commodity, but are barred from trading with each other, so that markets in the location are not integrated by construction, prices of the commodity could still be cointegrated across the markets, since supply across both locations will experience the same process of technological progress.[2]

A new avenue of spatial price transmission research has opened up in response to the increasing recognition of the significant role of transactions costs in spatial market analysis.[3] This strand of research employs parity bounds model (PBM) and threshold autoregressive (TAR) models. The standard PBM basically differentiates between three regimes, based on the price difference between two spatially separated markets. In regime one, trade may or may not be occurring and the spatial price differential is equal to transfer cost. This is normally represented as $P_t^1 - P_t^2 = TC_{12}$, where as in equation (1), P_t^1 and P_t^2 represent two markets located in different regions that may engage in trade. In regime two, the spatial price differential is less than transfer cost, and can be represented as $P_t^1 - P_t^2 < TC_{12}$. This represents

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were due to movements of population rather than food (Devereux, 1988).

[2] They point out that prices may be different across the markets in the short run, if short-run shocks on the commodity endowments (e.g., due to weather) are uncorrelated across the two locations.

a market condition where no profitable arbitrage opportunities exist between markets. Thus, the two markets may be in autarky but prices are efficient. In regime three, trade may or may not be occurring and spatial price differential is greater than the transfer cost, represented as $P_t^1 - P_t^2 > TC_{12}$. The spatial arbitrage condition is violated in this regime and the markets are not efficient but may be integrated to some extent if some trade is occurring.

The PMB has become very popular in spatial price analysis because of its inherent ability to include transfer costs in the analysis (Fafchamps and Gavian, 1996; Baulch, 1997; Barrett and Li, 2002; Moser et al., 2006; Negassa and Myres, 2007). Barrett and Li (2002) extended this framework by including information on actual trade flow patterns to examine trade in soybean meal among Pacific Rim economies. They demonstrated how knowledge of the existence of a continuous flow of goods between two markets generally enhances the interpretation of results from price transmission analysis.

Despite the advantages of the PBM, several weaknesses of the model remain unaddressed. As noted by Goodwin (1994), physical commodity trade is much more complex than financial arbitrage, – where this approach has been used to some extent – and presents greater difficulty in measuring transactions costs. In particular, transfer costs do not include risk premia and insurance, demurrage and information costs. These costs constitute a large proportion of transactions costs in commodity trade. Moreover, the PBM model offers only static comparisons and do not permit analysis of the dynamics of intertemporal adjustments to short-run and long-run equilibria.

Van Campenhout (2007) has also pointed out the disadvantage of the underlying distributional assumptions in the PBM. He argued that if there is no trade between two markets, because the price margin is lower than the transaction costs, as suggested by the PBM for regime 3, there is no reason why a smaller deviation from the parity bounds should

[3] A difficulty with the concepts accounting for transaction costs is that such costs are difficult to measure or

occur at a higher probability than a larger deviation, as suggested by the half-normal distribution underlying the model. However, a half-normal distribution appears appropriate if trade is occurring. The argument put forward by Van Campenhout is related to Fackler and Goodwin (2001) who argue that "switching regression models can be viewed as nothing more than flexible models of the price spread distribution. The believability of the regime interpretation rests very strongly on the believability of the distributional assumptions" Van Campenhout (2007) adds that "in a setting where markets are not logically linked by continuous trade, there is no reason to assume any adjustment in regime 3".

Threshold autoregressive (TAR) models account for potential nonlinearities and asymmetries in the adjustment of individual prices and provide more information regarding the dynamics of the data. The models recognize thresholds, caused by transactions costs that deviations must exceed before provoking equilibrating price adjustments that lead to market integration (Abdulai, 2000). TAR models provide both the probability of being outside the band (a measure of the degree to which the market violates spatial arbitrage condition) as well as a measure of the speed with which it eliminates these violations (Fackler and Goodwin, 2001).

A number of threshold specifications have been used in the empirical literature (e.g., Balke and Fomby, 1997; Enders and Granger, 1998; Enders and Siklos, 2001). To illustrate threshold adjustments, consider the relationship in equation (1) to be a dynamic long-run equilibrium relationship between prices in two spatially separated markets, or pieces at different levels in the value chain. Thus, P_t^1 and P_t^2 are either prices in the central and local markets, or wholesale and retail levels in the value chain, while ε_t is still considered to be a random error term with constant variance that can be contemporaneously correlated. As indicated earlier, long-run price transmission analysis test within this framework verifies

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observe.

whether any stable long-run relationship exists between the two price series. That implies ε_t (the price spread) should be stationary. Short-run price transmission tests aim to establish whether prices in different markets or at different levels respond immediately to this long-run relationship. This framework, however, assumes that the tendency to move to long-run equilibrium is always present. However, movement towards equilibrium may not occur in every period. In particular, the presence of transactions costs may prevent economic agents from adjusting continuously.

The two-regime momentum threshold cointegration model (MTAR) proposed by Enders and Siklos (2001) addresses this limitation by allowing the deviations from the long-run equilibrium to behave as a threshold autoregressive process: [4]

$$\Delta\varepsilon_t = \mathrm{I}_t\rho_1\varepsilon_{t-1} + (1-\mathrm{I}_t)\rho_2\varepsilon_{t-1} + \sum_{i=1}^{p}\gamma_i\Delta\hat{\varepsilon}_{t-i} + \mu_t \tag{3}$$

where I_t is the Heaviside Indicator function so that:

$$\mathrm{I}_t = \begin{cases} 1, & if\ \Delta\hat{\varepsilon}_{t-1} \geq c \\ 0, & if\ \Delta\hat{\varepsilon}_{t-1} < c \end{cases} \tag{4}$$

where c is the value of the threshold. Equations (3) and (4) represent a momentum threshold autoregressive cointegration model, in which the indicator variable I_t depends on the previous period's change in $\hat{\varepsilon}_{t-1}$, that is, the change in the spatial price spread. The adjustment is then modeled by $\rho_1\hat{\varepsilon}_{t-1}$, if $\Delta\hat{\varepsilon}_{t-1}$ is above the threshold and by the term $\rho_2\hat{\varepsilon}_{t-1}$, if $\Delta\hat{\varepsilon}_{t-1}$ is below the threshold. The threshold value c is estimated by using the sample mean of ε_{t-1} and if the null hypothesis of cointegration is rejected, the null hypothesis of symmetric adjustment $\rho_1 = \rho_2 = 0$ can then be tested using the standard F-statistic. Balke and Fomby (1997), Enders and Granger, 1998 and Lo and Zivot (2001) argue that if data are generated by TAR models

[4] Their model can also be presented as a three-regime model. Most empirical work using TAR has largely ignored specification testing of the imposed TAR models. Specification testing is particularly important in threshold analysis of LOP because the transaction cost theory that motivates the empirical specification of the TAR model imposes strong testable restrictions on the model (Lo and Zivot, 2001).

such as the one above, then standard unit root tests can have very low power, explaining why some cointegration tests have rejected market integration.

TAR models are particularly useful in examining asymmetric price responses in spatial and vertical price transmission. Consumer groups have often expressed concern that retail (downstream) prices rise more quickly than they fall given associated changes in wholesale (upstream) sector, making the study of asymmetric price transmission particularly interesting. In his study on price rigidity, Peltzman (2000) finds asymmetric price transmission to be the rule rather than the exception. Some of the commonly cited reasons for asymmetric price transmission include theories of local market power and search costs, inventory management strategies, and tacit or explicit collusion among firms in an oligopoly. Abdulai (2002) provides a detailed discussion on the rationale behind asymmetric price adjustments.

A limitation of the TAR approach is the assumption of constant transactions costs, implying a fixed neutral band over the period being studied. Transaction costs and the neutral bands which result may not be constant in the long run and may even be nonstationary (Barrett and Li, 2002). Van Campenhout (2007) attempted to address the problem of constant transaction costs over time, by including a time trend in both the threshold and the adjustment parameter in the TAR model. He then modeled the threshold as a simple linear function of time. To capture potential variation in transaction costs as a result of different policy regimes, Abdulai (2006) introduced different sub-samples in his analysis of the Ghanaian maize markets to represent the changing policy and economic environment. This strategy, however, requires *a prior* determination of potential breakpoints.

A limitation that is common to all the approaches is that they mostly assess the nature and degree of price transmission between spatially separated markets or along the value chain without addressing the underlying causes of the degree of price transmission. In a recent empirical study on grain markets in Ethiopia, Osborne (2005) found marked differences in

trader competition across different locations in Ethiopia, with the larger market with better communications more likely to enjoy competitive tradable equilibrium than smaller markets less well integrated into broader commercial networks. This indicates that studies on price transmission should increasingly attempt to examine the underlying causes of their findings.

Another issue that has not been adequately addressed in the empirical literature is the question of interseasonal flow reversals. In empirical analysis, agricultural commodities are normally assumed to flow continuously from rural areas to cities and towns. There are, however, exceptions where this flow occurs primarily during the harvest period and may actually reverse in the pre-harvest season as households in rural areas run out of grain stores and begin to purchase from cities and towns (Barrett, 2001). Thus, while knowledge that a continuous flow of goods existed between two markets is of importance, information on the direction of commodity flow throughout the year is equally useful in interpreting the results of spatial transmission tests. Moser et al. (2006) recently attempted to address some of the limitations of the standard PBM by incorporating both observed and unobserved transfer costs, and also to determine whether non-integration is due to high transfer costs or lack of competition. They also employed a simple probit model to address the question of interseasonal flow reversals.

3. Empirical Evidence

In this section, we present a review of the existing empirical evidence on spatial and vertical price transmission of commodity markets in Eastern and Southern Africa and then proceed to discuss the limitations of the studies as well as suggestions for future research. The review is based on a detailed literature search on journal articles, conference papers and unpublished manuscripts over the last two decades. The papers reviewed here are those we could access either through journals or the internet. Our search revealed a total of 22 publications on price

transmission in the commodity markets of Eastern and Southern Africa, which are now discussed below for the individual price transmission categories.

Spatial price transmission across regions

In his study on the impact of infrastructure on marketing in Rwanda, Loveridge (1991) used correlation coefficients to test for differences in market behavior associated with road construction. His empirical strategy involved estimating market pair regressions for the periods prior to paving the roads and the period after paving. He found that the reduced transfer costs associated with the new roads appeared to have caused price spreads between markets to become narrower due to increased arbitrage between geographically separated markets. He therefore concluded that the government's road-building effort had resulted in a higher level of food security than the country might otherwise have enjoyed.

Using cointegration and causality techniques, Goletti and Babu (1994) examined the impact of market liberalization on the integration of maize markets in Malawi, as well as the magnitude, speed and symmetry of price transmission among various markets for maize in the country. They introduced several measures of integration to analyze both the co-movement of prices and price adjustment over time. As in most of the studies that will be discussed, they studied the impact of market reforms by dividing their sample into two subsamples, the first Pre-Liberalization and the second Post-Liberalization, and then estimated cointegration regressions for the subsamples. Their findings indicated that maize markets are generally integrated and that liberalization that took place in 1987 had enhanced market integration, with the private sector playing a crucial role in improving the extent of price transmission. However, maize markets were found to display a low level of integration, as measured by the comovements of price changes across spatially separated markets. They also reported that maize markets do not exhibit a downward rigidity of prices, with supply (and demand) shocks transmitted equally. Goletti and Babu pointed out that market liberalization by itself cannot

achieve a structural change in market integration unless investments in marketing infrastructure such as transportation and communications are undertaken.

Using a vector autoregressive (VAR) cointegration approach, Chirwa (1999) investigated the integration of maize and rice markets by testing whether the Law of One Price holds in Malawi. Their empirical results showed that markets are highly integrated and the LOP was accepted in 97 percent and 69 percent of market links for maize and rice, respectively. These findings actually confirmed the earlier findings by Goletti and Babu (1994) for the maize market, although the author used a VAR cointegration approach, compared to the former who employed the two-step cointegration approach.

Dercon (1994) also employed cointegration and Granger causality framework to assess the impact of market liberalization on price transmission between main markets and peripheral markets for teff, the main staple in Ethiopia. His cointegration regression suggested that liberalization was able to reduce the margins between some of the main producing areas and the main consuming areas. The reforms also had some positive effects on the functioning of markets. Several markets became integrated with Addis Ababa, the capital, in the period after the policy change.

Loy and Wichern (2000) investigated both regional integration and international integration of maize markets in Zambia, also using cointegration techniques. They first employed an error correction model to estimate the level of market integration and then tested whether market reforms had contributed to an improvement in the regional interaction between markets. They further examined the development of spatial market integration between Zambian and Malawian maize markets, using Granger-causality test. The authors found that regional maize markets in Zambia are integrated, while some degree of integration of maize markets in Zambia and Malawi was also detected. However, the level of regional and

international market integration was quite low and did not increase significantly over time, as a result of high transaction costs on these markets.

A framework similar to the one used by Loy and Wichern (2000) was employed by Rashid (2004) in his study of spatial integration of maize markets in post-liberalized Uganda. His results showed that compared to early years of market liberalization, represented by the early 1990s, the extent of market integration in Ugandan maize markets appeared to have improved. However, markets located in the northern districts were found to lack integration with central markets, a result which was attributed to the state of insurgency in these districts since the government came into power in 1986. The author concluded that public policies, such as price stabilization, can have desired impacts if targeted at locations such as Kampala, Iganga and Lira, since price formation is dictated by these market locations.

Tostao and Brorsen (2005) measured the efficiency of spatial maize price arbitrage in Mozambique's post-reform period using the parity bound model (PBM). Given the high dependence of the PBM on the quality of transfer cost data, they complement their analysis with a bivariate vector autoregression to test for Granger causality between the pairs of markets studied. Their efficiency tests indicated that maize markets in central Mozambique are the most efficient, followed by markets in southern Mozambique. Spatial arbitrage between central and southern Mozambique was found to be efficient in 80-100% of the time. However, price spreads between maize markets in northern Mozambique and central/southern Mozambique fell below transportation costs nearly all of the time, suggesting that it did not pay to ship maize from the northern surplus region to southern Mozambique. They concluded that market liberalization seemed to have improved spatial price efficiency, but that high transfer costs limited trade and potential benefits from freeing the markets. According to them, food shortages and price instability are likely to continue under those circumstances. They

therefore recommended the development of low-cost rail or barge transportation, or improvement of roads, to reduce transport costs.

In a study of grain marketing policy changes in Ethiopia, Negassa and Myers (2007) employed an extended version of the parity bounds model to examine spatial efficiency of maize and wheat markets in Ethiopia. Their results showed that the effect of policy changes on spatial market efficiency was not significant in many cases, with a high probability of spatial inefficiency in maize and wheat markets before and after policy changes. They argued that the spatial inefficiency of these two markets is an indication that resources are being misallocated in transferring maize and wheat from surplus producing regions to deficit regions of Ethiopia. According to them, maize traders made losses most of the time while wheat traders made excess profits most of the time, suggesting that the two commodities might require different policy responses in order to improve spatial market efficiency.

Moser et al. (2006) use an exceptionally rich data set to test the extent to which markets in Madagascar are integrated across space at different scales of analysis and to explain some of the factors that limit spatial arbitrage and price equalization within a single country. Their approach involves the estimation of a PBM under the assumption of constant transfer costs and then a comparison of the results with those generated by an alternative, two-step procedure in which they first estimated the market-specific total (observed and unobserved) transfer costs and then used these costs to estimate the probabilities associated with the three market regimes in the PBM. As rightly noted by the authors, the latter approach however relies on the strong assumption that price differences, in expectation, reflect costs, with zero expected profits.

They found that markets are fairly well integrated at the sub-regional level, where nearly 70 percent of communes appear to be in tradable competitive equilibrium. However, markets at the national and regional (provincial) levels were found to be competitively integrated and

able to trade less than half of the cases. They attribute the low level of trade-in cases at the national level to prohibitively high transport costs that force segmented equilibria, while the lack of contemporaneous competitive spatial integration at the regional level was asserted to the likely existence of excess rents to spatial arbitrage, rather than to non-profit arbitrage. Factors such as high crime rates, remoteness, and lack of information were found to be among the factors limiting competition. Their policy message is that because markets are highly fragmented in Madagascar, both macro-level policies and micro-level development projects will likely not have the intended effects. They argue that integrating markets through reducing high transport costs and crime and by encouraging competition (at the regional level) needs to be a top priority for the government.

In a recent study, Van Campenhout (2007) extended the threshold autoregressive (TAR) model with a time trend to analyze market integration and price transmission in Tanzanian maize markets. To account for transaction costs and the speed of adjustment of market prices in spatially separated food markets, which are two critical components of inter-market arbitrage, he introduced a simple time trend to the threshold and the adjustment parameter. His results showed that a model that disregards transaction costs and does not include a time trend generates estimated half-lives ranging from 3.9 to more than 22 weeks.[5] After appropriately modeling the non-linear adjustment caused by transaction costs, half-lives declined to 4-11 weeks. Subsequently including a time trend resulted in a decrease in half-lives that ranged from one and a half to five weeks. He argued that studies that do not include a time trend frequently find values for half-lives that are unreasonably high given market settings. Van Campenhout concluded that government officials could make use of such findings to improve market performance in order to maintain food security. He specifically indicated that attention needs to be paid to the low level of market integration between the economic capital and the

[5] A half-life is the time that is needed for a given shock to return to half its initial value.

hinterland, and why trade between the eastern markets involves transaction costs that seem way too high given the distance.

Conforti (2004) also employed cointegration and causality methods to provide evidence on price transmission in a number of agricultural markets in Africa, Latin American and Asia. Both spatial and vertical price relations are considered in the analysis. His analysis for Ethiopia on spatial price transmission between world market and the domestic market showed that a long-run equilibrium between wheat retail price and the corresponding world reference price existed. The price transmission between maize retail and producer prices and world market prices were also found to be in a long run equilibrium relationship. However, for maize, the producer prices appeared to react to changes in the world reference price with a four month delay, whereas two more months were required for the wholesale price. Price transmission for wheat appeared to be faster, taking place within two to three months. He indicated that price transmission still occurred in countries that still regulated markets, suggesting that even interventionist policy environment cannot prevent domestic prices from following world trends and signals. He concluded that floor prices and other policies that represent wedges between domestic and world prices may overstate significantly the distortionary impact of such measures, if world prices are transmitted in the domestic market.

Vertical price transmission along the value chain

In their comprehensive study on horticultural marketing in Zimbabwe, Guvheya et al. (1998) employed Granger causality test and the Houck procedure to investigate farm-wholesale and wholesale-retail price causality. They found that prices flow from wholesale levels in both directions to farmers and retailers. On the issue of price transmission, their results indicated that only $0.35 of a $1 increase in wholesale prices were immediately transmitted to the farm level whereas $0.97 of a $1 price decrease at the wholesale level would be immediately transferred to the farm level or rural markets, indicating asymmetric

price transmission between these two levels. Their analyses however yielded symmetric price transmission between the wholesale and retail levels. They argued that the market structure along the channel is such that wholesalers wield greater market power on farmers, whereas market efficiency characterized the wholesale and retail levels. A limitation of these findings is the use of conventional regression analysis, without consideration of the time series properties of the price series.

Using both OLS and Generalized Least Squared methods, Traub and Jayne (2004) analyzed the effects of market reform on maize milling/retailing margins in South Africa. Their results showed that real maize milling/retailing margins increased further after the deregulation of prices and market reforms in 1997. After controlling for disturbances in weather, wages, exchange rate levels and volatility, inflation-adjusted margins accruing to millers and retailers had risen between 29% and 42% between 1997 and 2003. They pointed out that the simultaneous downward pressure on producer prices and higher maize meal prices indicated problems in the downstream stages of the marketing system. They concluded that unlike experiences in neighboring countries, the reform of the maize market in South Africa has not benefited consumers, but has rather exacerbated the country's food security problems.

Minten and Kyle (2000) examined retail margins, price transmission, and price asymmetry in urban food markets of Zaire. They showed that in the case of retail markets in Kinshasa, search, supervision, and other difficult to measure transaction costs are more important in the margin of food products than the measurable marketing costs such as storage and transport. They also employed the Houck specification to estimate price transmission between wholesale and retail levels, and found that while price increases at the wholesale level were in most cases completely transmitted within the same week to the retail level, this was not the case for price decreases. They also found that products characterized by more homogeneity and standardization behaved symmetrically while other products behaved asymmetrically.

According to them, a possible explanation for the finding of asymmetric behavior might be due to differences in product homogeneity such that search costs are less and that elasticities of prices are equal to elasticities of price decreases. They concluded that appropriate policies should focus on a reduction in transaction costs, which should involve, among other things, setting of grades and standards, as well as public gathering and dissemination of information and legally established mandatory reporting systems to improve marketing performance.

An earlier study by Minten and Kyle (1999) that examined the producer-wholesale price margin of domestic products between the urban centre of Kinshasa and rural areas found substantial rural regional and relative price variation, and that some of the variation was due to the effects of differing transport costs. Transportation was found to be on average two times more expensive on bad roads than on paved roads. The study also reported that producer shares decreased three times as fast on bad roads than on paved roads, a finding that shows the significance of road infrastructure in facilitating transport of agricultural commodities and improving farmers' income.

Getnet et al. (2005) modeled the equilibrium relationship between the producer and the wholesale prices of white teff, a major staple in Ethiopia, using the autoregressive distributed lag modeling (ARDL) approach to cointegration analysis. Their empirical strategy involved the bounds testing approach to the level analysis relationships (Pesaran et al., 2001), together with the ARDL modeling approach to cointegration analysis developed by Pesaran and Shin (1998). They used major demand and supply side variables to specify their function, which involved producer price of teff as a function of wholesale price of teff, wholesale price of white wheat as a substitute product, quantity of rainfall around the supply market, and the price of commercial fertilizer. They found that the wholesale price of white teff is a major short- and long-run determinant of the producer price in the supply markets, suggesting that the institutional role of the government with the aim of improving producers' marketing

margins and the overall performance of the grain markets in the post-liberalization period can be influenced through targeted interventions at the wholesale market. According to them, some of the possible mechanisms to raise wholesale prices include strategically targeting emergence stock procurement, augmenting effective demand, and enhancing trading capacities of the private sector at the market level. They see these measures as a possibility of avoiding the cost of intervention in the local markets and, at the same time, means of stabilizing producer prices.

Price transmission across countries

In their comprehensive study on market integration and price transmission in selected food and cash crop markets of developing countries, Rapsomanikis et al. (2006) also tested for market integration between coffee markets of Ethiopia, Rwanda and Uganda and the international market. The study used cointegration and Granger causality techniques to examine the extent to which coffee producers in these countries are integrated into the market process. The authors found that in Ethiopia and Uganda, domestic and international markets were integrated, with Granger causality tests indicating that international prices Granger cause domestic producer prices. Their results, however, showed absence of integration between Rwandan and international market. They argued that in Ethiopia, the supply chain from the producer to the exporter functioned well with the government administered auction system and quality control facilitating price transmission. In Uganda, growers sold their produce directly to traders and exporters, allowing domestic prices to be well connected to international prices. On the other hand, the absence of integration between the Rwandan and the international market was attributed to the government policy that isolated the Rwandan coffee market from the world economy.

Baffes and Gardner (2003) examined the transmission of world commodity prices to domestic markets under policy reforms in a number of developing countries using cointegration and error correction models. Their econometric investigation for Madagascar for the period 1970-91 showed that only a moderate improvement in market integration took place in the country after reforms. The 3-year adjustment period of domestic to international prices increased from 21 percent to 50 percent for rice and from 7 percent to 20 percent for coffee.

In a recent study on price transmission between world market and markets in developing countries, Kilima (2006) investigated the extent to which world market price changes are transmitted through changes in border prices into local producer prices for sugar, cotton, wheat and rice in Tanzania. As in the study by Rapsomanikis et al. (2006), the author employed cointegration and causality techniques to test for cross-border price transmission. His cointegration analysis showed that border prices in Tanzania were not well integrated with commodity prices in the world market. However, the Granger-causality test conducted revealed the existence of a unidirectional causal relationship, whereby commodity prices in the world market Granger-caused prices in Tanzania. He concluded that the impact of the ongoing trade reform in world markets might not have significant effects because of the partial transmission of price shocks from the world market to Tanzania. He therefore suggested that policy makers needed to reduce the monopoly power held by marketing institutions that distort commodity prices to enable producers benefit from rising world market prices.

4. Summary and research gaps

The studies surveyed and summarized in Table 1 indicate an accumulated evidence of the positive impact of market reforms on the extent and speed of price transmission between spatially separated markets. In most cases, trade liberalization allowed private traders to

actively participate in the marketing process, making prices to reflect information more effectively, and also allowing the transmission of incentives along the marketing chain. The increased competition and cost-effective private sector trading generally resulted in lower marketing margins and better integration of spatially separated markets. Although the transmission of prices from world commodity markets to domestic markets have also improved considerably, the results presented by Baffes and Gardner (2003) suggest that domestic markets in many countries still remain insulated with protective policies.

With regard to the methodologies employed, significant improvement in the approaches was observed over the period under consideration. Noteworthy is the fact that despite the acknowledgement of the existence of transaction costs in market transactions, most of the studies, with the notable exception of the studies by Negassa and Myers (2007), Tostao and Brorsen (2005), Moser et al. (2006), and Van Campenhout (2007), surveyed did not adequately handle non-linearities caused by transaction costs. A large majority of the studies employed cointegration methods, with the inherent disadvantages outlined earlier. Although the advantages of the TAR models are now widely known, only the study by Van Campenhout (2007) employed this framework in the empirical analysis.

Most of the studies that specifically examined the impact of trade policy changes on price transmission did so by dividing the samples into Pre-Liberalization and Post-Liberalization periods, and proceeded to examine price transmission between markets in the two periods without accounting for transactions costs that may inhibit price transmission across spatially separated markets. A consistent finding reported by studies using TAR models is that careful accounting for the unobservable threshold effects due to transaction costs reduces the likelihood that one rejects the hypothesis of market efficiency (Barrett, 2001). Hence, most of the studies that found no cointegration between spatially separated markets, leading to the conclusion of market segmentation might have reached wrong conclusions,

since such findings may have resulted from the neglect of transaction costs in their specifications.

In view of the lack of testable theoretical models from the economic literature, almost all the studies surveyed appear to be analyses of the relationship between two price time series.[6] In particular, the few studies on surveyed asymmetric price transmission followed the tradition in the empirical literature, whereby findings of asymmetric behavior are simply attributed to one or two of the competing theories of asymmetric price transmission. For example, Minten and Kyle (2000) attributed their findings of asymmetric price transmission to differences in product homogeneity and the related search costs, without exploring the potential presence of market power or inventory management. Guvheya et al. (1998) also attributed the asymmetry found in their analysis to the market structure along the channel, whereby wholesalers, by virtue of them being the smaller number of channel participants, are apt to wield greater market power than either producers or retailers. They however failed to test the link between market power and asymmetric price transmission. As pointed out by Meyer and v. Cramon-Taubadel (2004), it appears only a few studies have actually attempted to test the link between asymmetry and market power. In their study on consumer deposits, Neumark and Sharpe (1992) found that market concentration leads to asymmetric rigidities, while Pelzman (2000) found conflicting results in his study, using the number of competitors as well as market concentration as proxies for market power.

The preceding discussion shows that some potential fruitful research directions exist. First, there is the need to carefully link the empirical analyses to theoretical foundations. This would, however, require cross-sectional studies that would attempt to exploit differences in factors that explain price transmission across spatially separated markets or vertically along

[6] As pointed out by Balcome and Morisson (2002), many of the problems encountered in price transmission studies also occur in other contexts. An interesting discussion of these issues is presented in Stock and Watson (2001).

the value chain. Quite interesting would be structure and institutional characteristics of specific marketing chains. Second, rather than relying on arbitrary breakpoints based on policy regimes, as is commonly found in the price transmission literature, future work could employ strategies that involve searching over all possible breakpoints to determine significant breakpoints, particularly when the impact of policy change on price transmission is under investigation. As argued by Cashin and McDermott (2002), identifying breakpoints through data mining is inappropriate because the probability of false significant tests occurring is normally greater than assumed. A potentially useful framework is the parametric approach suggested by Andrews and Ploberger (1994) or the nonparametric approach by Cashin and McDermott (2002). Both procedures search over all possible break points to test for structural breaks and account for the fact that the breakpoints are dependent on the data.

Furthermore, an issue that deserves attention is data frequency. Most of the studies surveyed were based on monthly data, a problem that rather has to do with data availability. Nevertheless, as pointed out by Meyer and v. Cramon-Taubadel (2004), if price transmission occurs within days or weeks, monthly or even lower frequency price data will not adequately capture these transmission processes. Particularly where asymmetric price transmission takes place, employing data at higher frequencies such as quarterly data may lead to misleading results due to aggregation bias. Miller and Hayenga (2001) indicate that data testing for asymmetric price transmission in different ranges of the frequency domain can be employed to determine which explanations are not supported by the data in a specific setting. The authors explain that asymmetric price transmission caused by market power and search costs will be found in high-frequency cycles, but not low-frequency cycles, since market agents will normally search for and find better prices, if price changes last longer. Hence, if asymmetric price transmission is found in low-frequency-cycles, the explanations based on market power and search costs can be eliminated and attention rather focused on explanations consistent

with low-frequency cycles. However, as rightly pointed out by the authors, it will only be possible to narrow down the possible causes of asymmetric price transmission using this approach, but not to determine the specific cause.

Barrett and Li (2002) have argued that direct observation of trade flow and transport rate may be required to make accurate inferences on market integration. However, since this is not always possible over long periods of time, what is essential is to obtain sufficient information about the continuous flow of commodities between markets, as well as the direction of flow, prior to any empirical analysis. Such information can be particularly useful in the interpretation of the results. In addition, since it is obvious that the individual techniques reviewed here do have their limitations, it may be more interesting to base conclusions on different techniques rather than on a single technique. In particular, studies using new techniques could compare their findings with those obtained with older techniques, or apply the new methods to similar data that have been previously analyzed with old techniques.

5. Conclusions and implication for trade policy

Over the last two decades, many governments in Eastern and Southern Africa have embarked on various market reform measures aimed at improving commodity market performance. It is, however, widely acknowledged that the success of such market reforms depends to a large extent on the strength of the transmission of price signals between spatially separated markets and between different levels of the value chain. Spatial price transmission has been particularly useful in predicting the impact of price changes in producing areas on markets in food deficit areas. The nature, speed and extent of adjustment with which shocks are transmitted among producer, wholesale, and retail market prices is also a significant factor reflecting the actions of market participants at alternative market levels.

Hence, several studies have examined the impact of policy reforms on the nature, speed and extent of vertical and spatial price transmission in agricultural commodity markets in Eastern and Southern Africa. This paper has reviewed the methodologies employed in the empirical analyses, as well as the findings from these studies. The review showed that the techniques employed in studying price transmission have varied and improved over the last two decades, although several issues still remain unaddressed in the empirical analyses.

The empirical results from the studies indicate that commodity markets in Southern and Eastern Africa are generally well integrated, although the extent of integration varies between countries and commodities. The overall picture that emerged from the survey is that market reforms have enhanced price transmission between spatially separated markets, although the extent of market integration still remains low. A significant lesson of market reforms in almost all Southern and Eastern African countries has been the ability of private sector to respond to the improved operating environment and to improve the extent of price transmission between spatially separated markets. The low levels of market integration revealed by the studies, however, indicate that market reforms by itself cannot achieve a structural change in market integration unless investments in marketing infrastructure such as roads, transportation, communication, etc. are undertaken.

With respect to transmission of world price changes to domestic markets, the empirical evidence also indicates a significant increase in the extent of transmission from world to domestic markets for several products in many countries. However, the lessons from the findings show that the political impulse to insulate domestic markets from world commodity markets is remarkably persistent. Baffes and Gardner (2003) point out that even in the most liberalized countries they surveyed, price protection and/or insulation from fluctuations for some commodities survived every reform they surveyed. There is also accumulated evidence of asymmetric price transmission between levels of processing in the value chain. While price

increases at the wholesale level are in most cases completely transmitted within a short period to the retail level, this is not the case for price decreases.

The preceding discussions indicate that trade policy may enhance or hinder the price transmission, depending on the nature of the policy instruments in place. While liberalization of domestic agricultural markets has enhanced price transmission between spatially separated markets, insulation of domestic markets has hindered the transmission of world prices to domestic markets.

It is, however, evident from the studies surveyed that market liberalization is necessary, but probably not sufficient for achieving a structural change in market integration or complete pass-through of world prices to domestic prices. As pointed out in the various studies surveyed, price transmission between spatially separated markets and between world prices and domestic commodity markets can be substantially improved by reducing transaction costs, in particular, transport and information costs. Improved transport facilitates market development, expansion and fosters regional competition. Evidence presented in Spencer (1994) suggests that a major factor that explains the differences in the performance of agricultural markets in Asia and Africa is the level of infrastructure development and the cost of transport. Many governments in the region appear to have recognized this, and have already embarked on massive transportation projects to improve the transport situation in their countries.

As argued by Guvheya et al. (1998), market information plays a facilitative role in the marketing process for two main reasons. First, symmetrical access to market information improves the bargaining process during price discovery between transacting agents, resulting in pricing efficiency. Second, the availability of free information on regional product availabilities and prices is an important determinant of price transmission through its

facilitation of inter-market arbitrage. This public good nature of market information therefore calls for government provision.

References

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

Abdulai, A. 2002. Using Threshold Cointegration to Estimate Asymmetric Price Transmission in the Swiss Pork Market. *Applied Economics* 34(6), 679-687.

Abdulai, A. (2006). Spatial integration and price transmission in agricultural commodity markets in sub-Saharan Africa. In: Alexander S. and Hallam, D. *Agricultural Commodity Markets and Trade: New Approaches to Analyzing Market Structure and Instability.* Edward Elgar Publishers, pp. 163-186.

Alderman, H. (1993). Intercommodity price transmittal: Analysis of markets in Ghana. *Oxford Bulletin of Economics and Statistics,* 55(1), 43-64.

Andrews, D.W.K. and W. Ploberger. (1994). Optimal test when a nuisance parameter is present only under the alternative. *Econometrica*, 62, 1383-1414.

Badiane, O. and G.E. Shively. (1998). Spatial integration, transport costs, and the response of local prices to policy changes in Ghana. *Journal of Development Economics*, 56(2), 411-431.

Baffes, J. and B. Gardner. (2003). The transmission of world commodity prices to domestic markets under policy reforms in developing countries. *Reform Policy*, 6, 159-180.

Balcombe, K. and J. Morrison. (2002). Commodity price transmission: A critical review of techniques and an application to selected export commodities. A study for the Food and Agricultural Organization (ESCR) of the United Nations, Rome, Italy.

Balke, N.S. and T.B. Fomby (1997). Threshold cointegration. *International Economic Review*. 38, 627-645.

Barrett, C.B. (2001). Measuring integration and efficiency in international agricultural markets. *Review of Agricultural Economics*, 23(1), 19-32.

Barrett, C.B. and J.R. Li. (2002). Distinguishing between equilibrium and integration in spatial price analysis. *American Journal of Agricultural Economics*, 78, 825-29.

Baulch, B. (1997). Transfer costs, spatial arbitrage, and testing for food market integration. *American Journal of Agricultural Economics*, 84(2), 292-307.

Cashin, P. and C.J. McDermott. (2002). The Long-run behavior of commodity prices: Small trends and big variability. *IMF Staff Papers*, 49, 175-199.

Chirwa, E.W. (1999). Food marketing reforms and integration of maize and rice markets in Malawi. Department of Economics Working Paper No. WC/05/99. University of Malawi, Zoma, Malawi.

Chirwa, E.W. (2001). Food pricing reforms and price transmission in Malawi: Implications for food policy and food security. Department of Economics Working Paper No. WC/04/01. University of Malawi, Zoma, Malawi.

Conforti, P. (2004). Price transmission in selected agricultural markets. FAO Commodity and Trade Policy Research Working Paper No. 7. Commodities and Trade Division of the Food and Agricultural Organization of the United Nations, Rome, Italy.

Dercon, S. (1995). On market integration and liberalization: Method and application to Ethiopia. *Journal of Development Studies*, 32(1), 112-143.

Devereaux, S. (1988). Entitlements, availability and famine: A revisionist's view of Wollo 1972-74. *Food Policy*, 13(3).

Dwyer, G.P. and M.S. Wallace. (1992). Cointegration and market efficiency. *Journal of International Money and Finance*, 11(4), 318-27.

Enders, W. and C.W.J. Granger. (1998). Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates. *Journal of Business and Economic Statistics*, 16(3), 304-311.

Enders, W. and P.L. Siklos. (2001). Cointegration and threshold adjustment. *Journal of Business and Economic Statistics*, 19(2), 166-176.

Engle, R.F. and C.W.J. Granger. (1987). Cointegration and error correction: Representation, estimation and testing. *Econometrica*, 55(2), 251-280.

Fackler, P. and B.K. Goodwin. (2001). Spatial market integration. Handbook of Agricultural Economics. Amsterdam: North Holland.

Fafchamps, M. and S. Gavian. (1996). The spatial integration of livestock markets in Niger. *Journal of African Economies*, 5(3), 366-405.

Gardner, B. and K.M. Brooks. (1994). Food prices and market integration in Russia: 1992-1993. *American Journal of Agricultural Economics*, 76(2), 641-646.

Getnet, K., W. Verbeke and J. Viaene (2005). Modeling spatial price transmission in the grain markets of Ethiopia with an application of the ARDL approach to white teff. *Agricultural Economics*, 33, 491-502.

Goletti, F. and S. Babu. (1994). Market liberalization and integration of maize markets in Malawi. *Agricultural Economics*, 11, 311-324.

Goodwin, B.K. (1994). Oligopsony power: A forgotten dimension of food marketing. *American Journal of Agricultural Economics*, 76(3), 1163-1165.

Goodwin, B.K. and N. Piggott (2001). Spatial market integration in the presence of threshold effects. *American Journal of Agricultural Economics*, 83, 302-317.

Guvheya, G., E. Mabaya and R.D. Christy. (1998). Horticultural marketing in Zimbabwe: Margins, price transmission and spatial market integration. Staff Paper SP 98-02. Department of Agricultural, Resource, and Managerial Economics, Cornell University, Ithaca, New York 14853-7801, USA.

Johansen, S. (1998). Statistical analysis of cointegrating vectors. *Journal of Economic Dynamic and Control*, 12(2-3), 231-254.

Kilima, F.T.M. (2006). Are prices in the world market transmitted to markets in less developed countries? A case study of sugar, cotton, wheat, and rice in Tanzania. Institute for International Integration Studies Discussion Paper No. 160. Trinity College, University of Dublin.

Lence, S. and B. Falk. (2005). Cointegration, market integration, and market efficiency. *Journal of International Money and Finance* 24(6):873-890.

Lele, U. (1967). Market integration: a study of sorghum prices in Western India. *Journal of Farm Economics*, 49, 149-159.

Lo, M.C. and E. Zivot. (2001). Threshold cointegration and nonlinear adjustment to the Law of One Price. *Macroeconomic Dynamics* 5:533-576.

Loveridge, S. (1991). Marketing in Rwanda - imports and infrastructure. *Food Policy*, 16:95-104.

Loy, J.P. and R. Wichern. (2000). Integration of Zambian maize markets. *Quarterly Journal of International Agriculture*, 39:173-198.

Meyer, J. and S. von Cramon-Taubadel. (2004). Asymmetric price transmission: A survey. *Journal of Agricultural Economics* 55(3):581-611.

Miller, D.J. and Hayenga, M.L. (2001). Price Cycles and Asymmetric Price Transmission in the U.S. Pork Market. *American Journal of Agricultural Economics*, 83, 551-562.

Minten, B. and S. Kyle. (1999). The effect of distance and road quality on food collection, marketing margins, and traders' wages: evidence from the former Zaire. *Journal of Development Economics*, 60:467-495.

Minten, B. and S. Kyle. (2000). Retail margins, price transmission and price asymmetry in urban food markets: The case of Kinshasa (Zaire). *Journal of African Economies*, 9(1), 1-23.

Moser, C., Barrett C. and B. Minten. (2006). Spatial Integration at Multiple Scales: Rice Markets in Madagascar. SAGA Working Paper. Cornell University, Ithaca, New York, USA.

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

Nathan, S.B., and T.B. Fomby. (1997). Threshold cointegration. *International Economic Review*, 38(3), 627-645.

Negassa, A. (1998). Vertical and spatial integration of grain markets in Ethiopia: Implications for grain market and food security policies. Working Paper No. 9. Ministry of Economic Development and Cooperation, Addis Ababa, Ethiopia.

Negassa, A. and R. Myers. (2007). Estimating Policy Effects on Spatial Market Efficiency: An Extension to the Parity Bounds Model. *American Journal of Agricultural Economics*, 89(2).

Neumark, D. and Sharpe, S.A. (1992). Market Structure and the Nature of Price Rigidity: Evidence from the Market for Consumer Deposits. *Quarterly Journal of Economics*, 107, 657-680.

Osborne, T. (2005). Imperfect competition in agricultural markets: evidence from Ethiopia: *Journal of Development Economics*, 75(3):405-428.

Peltzman, S. (2000). Prices Rise Faster than they fall. Journal of Political Economy, 108(3), 466-502.

Pesaran, M.H., Shin, Y. (1998). An autoregressive distributed lag modeling approach to cointegration analysis. In: Strom, S. and Diamond, P., (Eds.), Centennial Volume of Regnar Frisch. Cambridge University Press, Cambridge.

Pesaran, M.H., Shin, Y. and Smith, R.J. (2001). Bounds testing approach to the analysis of level relationships. *Journal of Applied Econometrics*, 16, 289-328

Rapsomanikis, G., Hallam, D. and P. Conforti. (2006). Market integration and Price transmission in selected food and cash crop markets of developing countries: Review and applications. In: Alexander S. and Hallam, D. *Agricultural Commodity Markets and Trade: New Approaches to Analyzing Market Structure and Instability.* Edward Elgar Publishers, pp. 187-217

Rashid, S. (2004). Spatial integration of maize markets in post-liberalized Uganda. *Journal of African Economies*, 13(1), 102-133.

Ravallion, M. (1986). Testing market integration. *American Journal of Agricultural Economics*, 68(1), 102-109.

Sen, A.K. (1981). Poverty and Famines. Oxford, Clarendon Press.

Spencer, D.S.C. (1994). Infrastructure and technology constraints to agricultural development in the humid and sub-humid tropics of Africa. EPTD Discussion Paper No. 3, International Food Policy Research Institute, Washington, D.C.

Stigler, G.J., and R.A. Sherwin. (1985). The extent of the market. *Journal of Law and Economics*, XXVIII(3), 555-85.

Stock, J.H. and M.W. Watson. (2001). Vector Autoregressions. *Journal of Economic Perspectives*, 15(4), 101-115.

Timmer, C.P. (1987). The Corn Economy of Indonesia. Cornell University, Ithaca, New York, USA.

Traub, L.N. and T.S. Jayne. (2004). The effects of market reforms on maize marketing margins in South Africa. MSU International Development Working Paper No. 83. Michigan State University, East Lansing, Michigan 48824.

Tsay, R.S. (1989). Testing and modeling threshold autoregressive processes. *Journal of the American Statistical Association*, 84:231-240.

Tong, H. (1983). Threshold models in non-linear time series analysis. Springer-Verlag: New York.

Tostao, E. and B.W. Brorson. (2005). Spatial price efficiency in Mozambique's post-reform maize markets. *Agricultural Economics* 33, 205-214.

Van Campenhout. (2007). Modeling trends in food market integration: Method and application to Tanzanian maize markets. *Food Policy* 32, 112-127.

Webb, P., J. von Braun and Y. Yohannos. (1992). Famine in Ethiopia: Policy implications of coping failure at national and household levels, Research Report 97. International Food Policy Research Institute, Washington, D.C.

Table 1: Summary of Empirical Analysis on Spatial and Vertical price transmission in food staples market chains in Eastern and Southern Africa

Trans-mission	Authors	Year	Country	Commodity	Period	Approach
Spatial	Loveridge	1991	Rwanda	Dry beans	1985	Correlation coefficient
	Goletti and Babu	1994	Malawi	Maize	01/1984 – 12/1991	Cointegration/ causality
	Dercon	1995	Ethiopia	Teff	07/1987 – 09/1993	Cointegration/ causality
	Chirwa	1999	Malawi	Maize and rice	1989 – 1998	Cointegration/VAR
	Chirwa	2001	Malawi	Maize/rice/beans/ groundnuts	1989 – 1998	Cointegration/ causality
	Loy and Wichern	2000	Zambia and Malawi	Maize	01/1994 – 06/1998	Cointegration/ causality
	Rashid	2004	Uganda	Maize	1993 – 1994 and 1999 – 2001	Cointegration/ causality
	Tostao and Brorsen	2005	Mozambique	Maize	1994 – 2001	PBM/causality
	Negassa and Myers	2007	Ethiopia	Maize and wheat	08/1996 – 08/2002	PBM
	Moser et al.	2006	Madagascar	Rice	2000 – 2001	PBM
	Van Campenhout	2007	Tanzania	Maize	1989 – 2000	TAR
	Conforti	2004	Egypt/Ethiopia	Food and cash crops	Egypt: 01/1969 – 05/2001 Ethiopia: 09/1993 – 05/2001	Cointegration/ causality
Vertical	Guvheya et al.	1998	Zimbabwe	Tomatoes	1996	Causality/Houck
	Negassa	1998	Ethiopia	Grain	08/1996 – 08/1997	Correlation coefficient/causality
	Traub and Jayne	2004	South Africa	Maize	05/1976 – 09/2003	OLS/Generalized Least Squares
	Minten and Kyle	2000	Zaire	Food	1987 – 1989	SURE/Houck
	Getnet et al.	2005	Ethiopia	White teff	01/1996 – 12/2000	Cointegration/ ARDL
Across countries	Rapsomanikis et al.	2006	Ethiopia/Rwanda/ Uganda	Coffee	01/1990 – 12/2001	Cointegration/ causality
	Baffes and Gardner	2003	Madagascar	Coffee/rice/sugar	1970 – 1991	Cointegration/ error correction
	Kilima	2006	Tanzania	Sugar/cotton/ wheat/rice	06/1994 – 06/2005	Cointegration/ causality

Note: ARDL refers to autoregressive distributed lag modeling. PBM refers to parity bounds model. SURE is used to denote seemingly unrelated regression estimation.