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Maize Price Differences and Evidence of Spatial Integration in Malawi

The Case of Selected Markets

Lovemore Nyongo

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ABSTRACT

This study tests the long-run and short-run integration of maize markets in Malawi using the co-integration approach within the Vector Autoregressive modeling framework. The analysis is extended to Wald-F Granger Causality tests to see the direction of causality between maize markets. A total of six maize markets, two from each region, were analyzed. Three are urban markets, while two of the three rural markets are border markets. The study uses monthly maize retail prices for the period January 2000 to May 2008. Study findings show that nine out of the fifteen market pairs are integrated in the long-run, but the degree of short-run market integration is low, implying that the transmission of price information is slow. Transaction costs seem to have a significant impact on the integration of market pairs involving border markets. Furthermore, there is no market that qualifies to be a central maize market in this study. The study concludes with a discussion of policy action to improve maize market integration and food security in Malawi.

Keywords: Market integration, co-integration, transaction costs, price transmission.

1. INTRODUCTION, BACKGROUND AND MOTIVATION FOR STUDY

In countries where the majority of the people are net food buyers, strengthening markets is a key strategy to achieve food security. Spatial market integration becomes a useful tool in distributing food within such countries from surplus to deficit areas. By definition, spatial market integration refers to a measure of the extent to which demand and supply shocks in one location are transmitted to another location (Negassa et al, 2003). If markets are well integrated, price changes in one location are consistently related to price changes in other locations, thereby facilitating interactions among market agents. In spatially integrated markets, competition among arbitragers ensures that a unique equilibrium is achieved where local prices in regional markets differ by no more than transportation costs. According to Sexton et al. (1991) information on spatial market integration provides indication of competitiveness, the effectiveness of arbitrage, and the efficiency of pricing.

If markets are not integrated, the information they convey may not be accurate. Inaccurate price signals sent in a poorly integrated market system may distort both producers' and consumers' marketing decisions. This will tend to result in traders exploiting the market and benefitting at the expense of both producers and consumers (Goodwin and Schroeder 1991). On the other hand, in more integrated markets, farmers specialize in their production, consumers pay less, and the society benefits from economies of scale (Goodwin and Schroeder 1991). In addition, the degree of market integration informs policy makers in their analysis of food security and in guiding appropriate responses to a food crisis.

This study analyzes spatial maize market integration in the Malawi economy. The importance of maize as a staple food crop in Malawi underlines the relevance of this study. Specifically, the study has the following objectives:

1. To investigate price transmission mechanism across selected maize markets in Malawi.
2. To establish if there are central maize markets in the economy.
3. To assess the impact of transaction costs on maize market integration.

Although households grow a wide diversity of crops, maize is the most important food crop in the consumption basket of most Malawians. In their study, Chirwa and Zakeyo (2003) reported that 93.2 percent of all sampled farming households cultivated maize. Secondly, the country's Consumer Price Index (CPI) is dominated by maize, so that any change in its supply on the market has a significant impact on the level of inflation (GoM 2007)[1].

The literature on market integration is vast. For Malawi, however, there are four main studies that have analyzed domestic maize market integration. Three of them have used co-integration methods (Goletti and Babu 1994; Chirwa 1999; Mulaga 2007), while one has used a Threshold Autoregressive (TAR) approach (Myers 2008). Co-integration approaches have been criticized for not taking into account transaction costs (Faminow and Benson, 1990). In order to capture these costs, this study used transportation costs as a proxy for transaction costs within a Vector Autoregressive (VAR) modeling framework. By incorporating transaction costs, this study goes beyond earlier studies on maize market integration in Malawi.

2. THEORETICAL LITERATURE

In a market driven economy, the marketing system serves at the micro and macro levels as a mechanism to transmit information that is useful in decision-making to market participants. Pricing signals guide and regulate production, consumption and marketing decisions over time, form, and place (Kohls and Uhl 1998). According to Negassa et al.

[1] 58.1 percent of the CPI is determined by price changes in food items, with maize being the major staple food considered.

(2003), the price relationship between spatially separated markets is generally analyzed within the framework of spatial price equilibrium theory developed by Enke (1951), Samuelson (1964), and Takayama and Judge (1964). The key assumption underpinning the theory is that price relationships between spatially separated competitive markets depend on the size of transaction costs. When the price difference between markets exceeds transaction costs, arbitrage opportunities will becreated and profit seeking merchants will purchase commodities from a low-price surplus market and transfer them to a higher-priced deficit market.

3. SAMPLE DESCRIPTION, DATA SOURCES AND ESTIMATION

This study of the integration of maize markets in Malawi uses monthly retail maize prices for the period January 2000 to May 2008 (Figure 1). During this period, maize marketing was almost fully liberalized except for sporadic government interventions depending on maize availability. Data was collected from various sources including the Ministry of Agriculture and Food Security, the National Statistical Office, and FEWSNET Malawi. Data on fuel prices was collected from British Petroleum Malawi Ltd. Six geographically separated markets were examined, two from each of the three regions of the country. One urban, commercial market center (Mzuzu, Lilongwe, and Limbe) and one rural market (Chitipa, Ntchisi, and Muloza) were included in the study from each region. The study used the analytical framework adopted from Rapsomanikis et al. (2005), as presented in Figure 2

Figure 1—Monthly average nominal maize prices, selected Malawi markets, Jan 2000 to May 2008

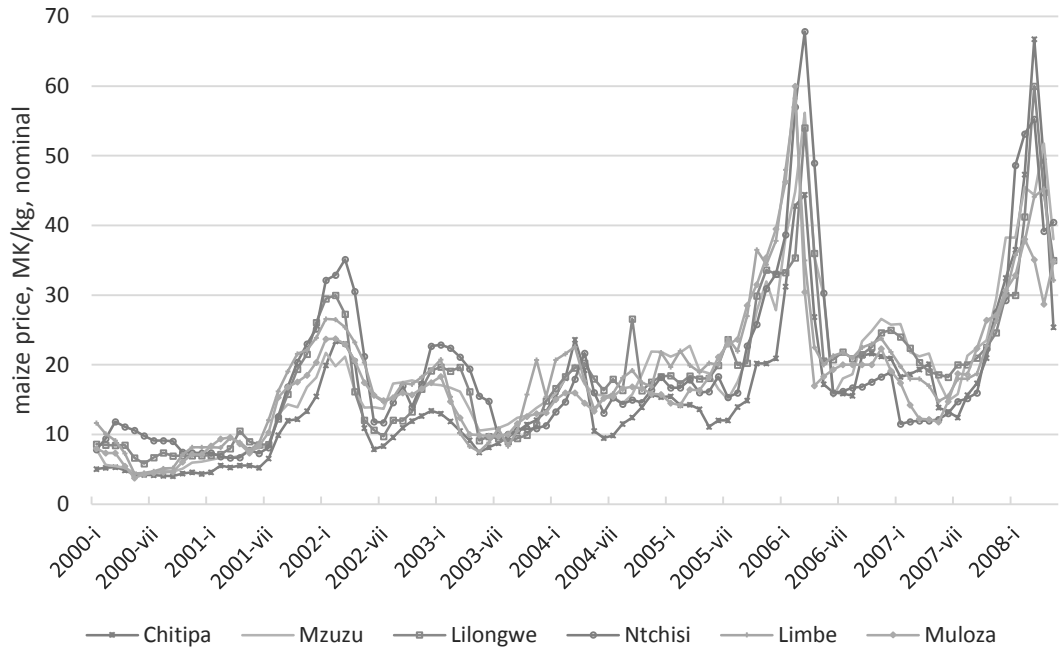
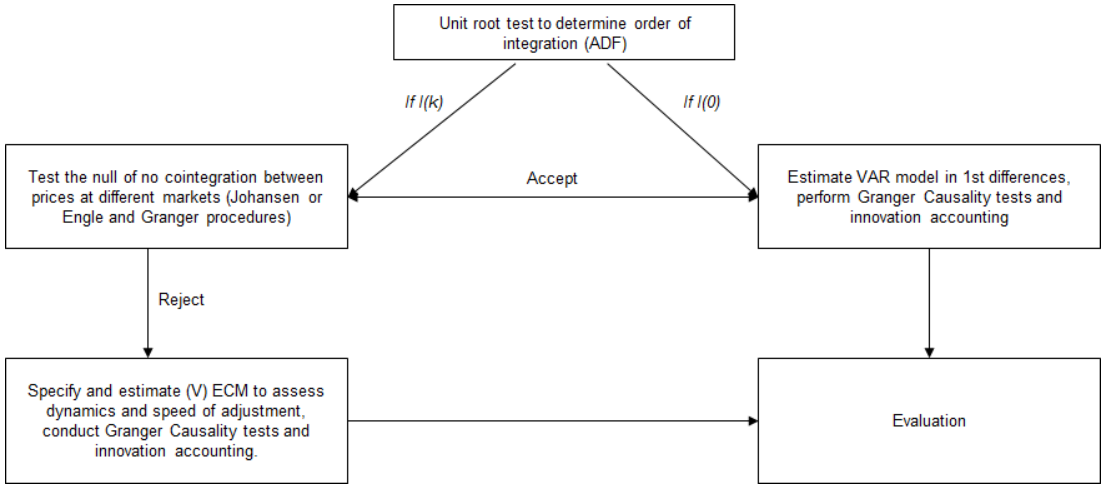


Figure 2—Analytical framework for the Cointegration Analysis procedure



Notes: k>0, k is the order of integration.
Source: Modified from Rapsomanikis *et al.* (2005).

3.1 Co-integration Analysis and Error Correction Model

If geographically separated markets are integrated, then there exists an equilibrium relationship among these markets (Sexton et al. 1991). The long-run equilibrium relationship to study market integration, according to the theory of law of one price (LOP), is specified as:

$$P^i_t = \beta_1 + \beta_2 P^j_t + \varepsilon_t \quad (1)$$

Where P_t^i and P_t^j are price series for market i and j respectively in period t and ε_t is an error term assumed to be stationary. β_1 is a constant which is assumed to account for transport and other transfer costs (Chirwa, 2004). β_2 is the parameter to be tested. If ε_t is stationary and β_2 is unity, we can conclude that the markets are completely integrated and this implies that a price change in one market will be transmitted to the other market.

In the study, the relationship in equation 1 was modified to include other variables that are found or assumed to influence market integration based on the literature reviewed. First, natural logarithms are introduced within the Vector Autoregressive framework so that the estimated coefficients are interpreted directly as elasticities (Gujarati, 2003). Secondly, transaction costs (TC) are included to capture transfer costs from one market to another[2]. The model is as follows:

$$\ln p_t^i = \beta_1 + \sum_{i=1}^{n} \alpha_i \ln p_{t-i}^j + \sum_{l=1}^{n} \eta_l \ln p_{t-l}^i + \beta_2 \ln TC_t + \varepsilon_t \quad (2)$$

where ln = natural logarithm, p^i_{t-l} and p^j_{t-i} are lagged prices in market i and j. TC_t is transaction cost in period t and is an exogenous variable. β_1 is an intercept term. β_2, α_i and η_l are slope parameters, while ε_t is an error term.

The long run relationship in equation 2 may not be satisfied at each time period. If the existence of co-integration is established, the relationship between markets can be expressed in an Error Correction Model (ECM) which depicts the process of adaptation between prices in the short run (Engle and Granger 1987). Therefore, a Johansen Co-integration test was conducted to see if price series were co-integrated. To determine the number of co-integrating relations in the system, the study invoked the Johansen Trace test and Maximum Eigenvalue. Failure to accept the null hypothesis of no co-integration confirmed the need to re-specify equation 2 as a Vector Error Correction Model (VECM), as in equation 3:

$$\Delta \ln p_t^i = \beta_1 + \sum_{l=1}^{q} \alpha_l \Delta \ln p_{t-l}^i + \sum_{l=1}^{q} \theta_l \Delta \ln p_{t-l}^j + \lambda_i \chi + \phi_1 \ln TC_t + \nu_t \quad (3)$$

Where v_t is a stochastic disturbance term assumed to be white noise, $\chi = \ln p_{t-1}^i - \mu \ln p_{t-1}^j - \pi$ is a co-integrating equation and μ is the co-integrating parameter that characterizes a long run relationship between the two prices. The parameter of interest is λ_i, the speed-of-adjustment, indicating the speed at which the system returns to equilibrium in case of a shock. If these parameters are equal to zero, then there is no adjustment to the deviation from the long-run equilibrium, while an absolute value of one suggests rapid adjustment. $\lambda_i\chi$ is an Error Correction Term (ECT) since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. Θ_l and α_l are short run parameters capturing price transmission. β_1 is a constant while ϕ_1 is a slope coefficient for transaction costs. The rest of the variables are as defined before. To appreciate the impact of transaction costs, equation 2 and 3 were estimated with and without transaction costs for each market pair.

The Granger causality test was conducted to determine the direction of price adjustment (Bassolet and Lutz, 1999). The test was used to determine the existence of central markets in the process of price transmission. We conducted the Wald F-test for linear restrictions to find out if one market's lagged prices and transaction costs jointly contribute to predictability of maize prices in another market. Equation 2 was used to conduct the test.

4. RESULTS AND INTEPRETATION

4.1. Unit Root Test Results

Graphical presentation of the series indicated the presence of both intercept terms and stochastic trend terms. As such, the study invoked a unit root test equation with both the intercept term and the time trend term. To have an idea on stationarity, Autocorrelation Functions (ACF) and Partial Autocorrelation Functions (PACF) were computed[3]. For all price series, the ACF were statistically significant at the beginning and exhibited a sine wave pattern as the lag length was

[2] Transaction costs are the product of the average fuel price at time t and the distance between the markets to be analyzed.

[3] A time series is stationary if the mean, variance, and covariance of the series are not dependent on time.

extended to 36 lags. On the other hand, the PACF had a significant spike at lag 1 in all series indicating 1 lag for each series. This provides evidence for nonstationarity which can be buttressed by ADF tests. To formally determine the appropriate lag length, AIC and SIC were used. Both statistics suggested one lag for all maize prices, except Chitipa which required two augmentations to whiten the residual.

4.2 VAR Order Determination

The VAR order selection used a maximum lag length of 12. Specification results for each market pair are shown in Table 1.

Table 1—VAR order specification by market-pair

	Mzuzu	Chitipa	Lilongwe	Ntchisi	Limbe
Chitipa	(8)				
Lilongwe	(1)	(1)			
Ntchisi	(1)	(8)	(1)		
Limbe	(7)	(8)	(10)	(6)	
Muloza	(10)	(8)	(2)	(8)	(1)

4.3 Johansen Co-integration Test Results

The unit root tests established that all maize price series are integrated of order 1. As such, the variables could potentially be co-integrated meaning that there exist long run relationships among them. Therefore, the study conducted the Johansen Co-integration test to ascertain this. Each market pair was subjected to the test with both trend term and an intercept. P-values were used to evaluate the test statistics at a 5 percent significance level.

The results shown in Table 2 indicate that, out of the 15 market pairs analyzed, nine had one co-integrating relationship, while six had no co-integrating relationships. The long run relationships imply that a price rise in one market will lead to a price decrease in the other market. Ntchisi seems to be separated from the rest of the markets. Out of five market pairs involving Ntchisi, four show an absence of a long-run relationship. Muloza is the only market that Ntchisi is linked with; yet they are physically somewhat more disjointed than the other market pairs involving Ntchisi. Chitipa is another market which also is significantly separated physically from the most of the other markets. Out of the five pairs involving Chitipa, three are not integrated. For Ntchisi, the lack of long run relationships may not be surprising because Ntchisi was chosen to represent chronically maize deficit regions of the country. The lack of integration could be the major reason for the perpetual maize deficit in the district. Poor transport infrastructure connecting Ntchisi to other districts could be a major reason for the lack of long run relationships[4]. Chitipa, located in the far northwest of Malawi, is not integrated with the markets in the southern region, Limbe and Muloza, and this could be due to the long distances separating Chitipa and these markets. Poor transport infrastructure connecting Chitipa to other districts may have played a role as well. There is also a possibility of Chitipa trading with Tanzanian markets across the northern border in preference to markets in Malawi.

Table 2—Presence of a co-integrating relationship, by market-pair

	Mzuzu	Chitipa	Lilongwe	Ntchisi	Limbe
Chitipa	yes				
Lilongwe	yes	yes			
Ntchisi	**no**	**no**	**no**		
Limbe	yes	**no**	yes	**no**	
Muloza	yes	**no**	yes	yes	yes

The study proceeded to estimate a VEC model (equation 3) with one co-integrating relationship for the nine co-integrated market pairs. The existence of co-integrating equations in these market pairs confirm that the dynamic causal relationships among the maize prices can also be investigated using Granger-causality tests and innovation accounting within the environment of VEC models (Mangani 2005). A linear deterministic trend was assumed in estimating the VEC. For the equations that had no co-integrating relations, a VAR model (equation 2) was estimated, followed by Granger causality tests.

[4] Ntchisi had no paved road until December 2007 when Ntchisi-Mponela road was officially opened.

4.4 Impact of Transaction Costs

Transaction costs were found to be statistically significant at a 5 percent level of significance for the market pairs of Chitipa-Mzuzu and Muloza-Mzuzu, and at a 10 percent level of significance for Lilongwe-Muloza. Estimating the same equations without transaction costs, a few changes are noted. The speed of adjustment for Chitipa in the Chitipa-Mzuzu equation drops from 46 to 31 percent and is no longer significant. The one lag price for Chitipa no longer affects current price for Mzuzu at the 5 percent level. Secondly, the adjustment speed of Lilongwe to disequilibrium in the Lilongwe-Limbe equation declines from 33 percent to 29 percent and is still significant. Similarly, if transaction costs are not considered, the one lag price for Limbe does not affect current prices at Mzuzu. Thus, with no transaction costs, the price transmission process seems to be delayed.

An unexpected change is noted on results for the Chitipa-Lilongwe equation. Without transaction costs, the ECT's for both equations are now significant at the 5 percent level. Lilongwe corrects 22 percent of the disequilibrium every month while Chitipa corrects 23 percent of the disequilibrium every month. For Muloza-Mzuzu, without transaction costs the speed of adjustment for Muloza jumps from 13 percent to 33 percent and is statistically significant at 5 percent. Similarly, the speed of adjustment for Mzuzu jumps from 10 percent to 25 percent. These markets are connected by a paved road, but are 725 km away from each other. Finally, the speed of adjustment for Lilongwe in the Lilongwe-Muloza equation drops from 36 to 28 percent. This is also the case with Muloza-Ntchisi where the speed of adjustment for Ntchisi drops from 72 percent to 66 percent if transaction costs are not considered.

These results indicate that equations for market pairs that include border markets are more likely to be affected by transaction costs. A unique feature for Chitipa is the poor road network connecting it to other markets in Malawi. If we consider transaction costs in our analysis, the speed of adjustment for Chitipa improves and becomes significant. This concurs with findings by van Campenhout (2005) who found transaction costs to improve speed of adjustment in Tanzania. On the other hand, the response of the equations involving Muloza is mixed. When paired with Muloza, the speed of adjustment for Mzuzu decreases, while for Ntchisi it increases if transaction costs are considered. We can therefore conclude that transaction costs have a significant impact on market integration, especially on equations involving the border markets and those markets that have poor road links to other markets.

In the study, the short-run speed of adjustment between market pairs ranges from 10 percent to 72 percent if transaction costs are considered, and from 21 percent to 66 percent when transaction costs are not considered. The speed of adjustment for Ntchisi in the Ntchisi-Muloza equation is very high and differs from the rest. The short-run speed of adjustment ranges from 10 to 46 percent and 21 to 30 percent with and without transaction costs, respectively. This implies that in general, transaction costs reveal the volatility of market adjustment and should, therefore, be considered when analyzing spatial market integration. Apart from Ntchisi, none of the other markets have an adjustment speed above 50 percent. The low speed of short run adjustment is an indication of the existence of policy and structural problems which hinder efficient private maize trade in the country. Government intervention in the maize market through the Agricultural Development and Marketing Corporation (ADMARC), National Food Reserve Agency (NFRA), and bans on private maize trade during lean seasons also slows down the short run response of markets to shocks in the country.

In addition to that, in all the equations with transaction costs, only three had statistically significant transaction cost coefficients. This suggests the need to include other components of transaction costs in the study. Such components include; government policies on movement of maize, licensing procedures, delays in accessing price information, and storage capacity constraints.

4.5 Granger Causality Tests

One of the specific objectives of this study was to establish if there existed central maize markets in Malawi. From the Granger causality tests, as shown in Table 3, none of the markets qualifies to be a central market. No market causes price movements in all other markets without other markets also causing price movements in that market.

However, Muloza and Limbe seem to Granger cause five and four other markets, respectively and, therefore, could be good markets for policy intervention. The interesting finding is that Lilongwe Granger causes Chitipa and is Granger caused by Mzuzu, both of which are in the northern region. This is in contrast with Goletti and Babu (1994) who found Lilongwe not to be well integrated with the northern region. Lilongwe seems to be a major supplier of maize to all three regions because it is Granger caused by Mzuzu, Ntchisi, Limbe and Muloza. This supports Myres (2008) assertion that major interregional maize flows are from the center to the south, with irregular flows in both directions between the center and the north, depending on the season.

Table 3—Granger causality Wald F-test results, by market-pair

Dependent market	Independent market					
	Mzuzu	Chitipa	Lilongwe	Ntchisi	Limbe	Muloza
Mzuzu		1.745	2.278	1.431	3.782 **	4.377 **
Chitipa	5.381 **		3.492 **	1.524	1.453	3.722 **
Lilongwe	3.016 **	2.339		2.982 **	2.505 **	3.063 **
Ntchisi	2.102	1.615	2.072		2.636 **	3.688 **
Limbe	0.511	8.571 **	1.525	1.179		3.680 **
Muloza	0.628	0.909	1.960	0.876	4.886 **	

Notes: The null hypothesis being evaluated here is whether maize market price movements in the independent market, plus transaction costs, do not jointly Granger cause maize market price movements in the dependent market.
** indicate significance at 5 percent level

5. CONCLUSION AND POLICY IMPLICATIONS

An assessment of the long run price equilibrium relations among selected maize markets in Malawi shows the existence of market integration. However, short run integration is very low, implying that it takes a longer period for maize markets to respond to localized shocks. Therefore, it is essential that policy makers should consider market infrastructure development as a key priority to ensure linkages of isolated maize markets.

It is also important to note that maize marketing in Malawi is complex and dynamic. It is, therefore, important to continuously study the maize market for Malawi and see how the individual maize markets relate. Unless we have knowledge on maize market dynamics, achievement of food security in a liberalized economy will remain a farfetched dream.

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About the Author

Lovemore Nyongo is with the Department of Agriculture Planning Services of the Ministry of Agriculture and Food Security,

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

2033 K Street, NW | Washington, DC 20006-1002 USA | T+1.202.862.5600 | F+1.202.457.4439 | Skype: ifprihomeoffice | ifpri@cgiar.org

IFPRI-LILONGWE

P.O. Box 31666 | Lilongwe 3, Malawi | T +265-1-771780 | ifpri-lilongwe@cgiar.org