MALAWI
Strategy Support Program

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI
A member of the CGIAR Consortium

WORKING PAPER 07 | July 2014

Spatial price integration among selected bean markets in Malawi

A threshold autoregressive model approach

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ABSTRACT

This research examines the extent of market integration among different bean markets across Malawi. Market integration is an indicator that efficiency exists within the flow of information between markets. The study focused on beans as they are a cheap source of protein affordable by the majority of rural smallholder farmers. Market price data for beans was obtained from the Ministry of Agriculture and Food Security and covered the period 1995 to 2011. The markets included in the study are Chitipa, Rumphi, Mzuzu, Lilongwe, Mitundu, Lizulu, Lunzu, Luchenza, and Bangula. Like prices of other agricultural crops, bean prices follow a general seasonal pattern, rising with increasing time since the last harvest and decreasing during the harvest period. Bean prices typically peak in December when bean supply to the market is low. The research results show that beans prices in different markets move in the same direction, meaning that the markets are co-integrated. However, price information is not fully transmitted between markets. Transaction costs were found to be higher in markets which are far away from major cities and in those markets serviced by poor roads. Based on the results, the study recommends the need to improve infrastructure and market information systems to enhance bean market efficiency in Malawi.

Keywords: Malawi, market integration, bean markets, transaction costs, threshold autoregressive model

1. INTRODUCTION

Marketing of agricultural produce in Malawi has experienced major changes over the past 30 years from the use of marketing boards to a liberalized and more diversified marketing system. The government of Malawi in the 1980s began implementing a program of macroeconomic adjustment, the Structural Adjustment Program, that was supported by the International Monetary Fund, the World Bank, and bilateral and multilateral donors. One of the requirements of this economic reform was the liberalization of the marketing of agricultural inputs and commodities to allow the private sector to play a greater role. Until these reforms, the marketing of agricultural commodities was monopolized by the Agricultural Development and Marketing Corporation (ADMARC), the state-controlled marketing board. Market liberalization was expected to lead to more efficient marketing through competition and to improve the allocation of resources by farmers by allowing market forces to play a greater role in their production decisions (Crawford 1997). However, the impact of these reforms on Malawian smallholder farmers has been mixed, due mainly to inefficiencies in both input and output markets as a result of a poor macroeconomic environment and lack of market information (Sopo 2008).

Several studies have looked at the response of traders to the liberalization of smallholder agriculture marketing activities in Malawi and highlighted the problems and constraints they continue to face (Scarborough 1990, Kaluwa 1992, Chirwa 1998). Among the main constraints faced by traders are limited credit availability, limited transport, high transport costs, inadequate storage facilities, poor marketing skills, lack of market information, and restricted flow of information on prices. Considering that economic theory views market efficiency and market integration as among the chief positive effects of market liberalization, it is important to test whether liberalization in Malawi has led to improved market efficiency and enhanced integration. This is particularly important considering that Malawi, in common with most developing countries, still faces many structural challenges. The structural challenges stem from continued economic dependency on an agricultural sector that is characterized by low output prices, a narrow export base, and low investments in infrastructure development. These challenges have implications for trade and agricultural development, both of which are essential to stimulate growth in economic sectors outside agriculture. Therefore, better prices or reduced transaction costs in commodity value chains may stimulate growth in the agricultural sector and increase trade levels. Prices of agricultural commodities determine the supply of commodities by farmers, as the crop prices that farmers anticipate after harvest are used by farmers in making informed decisions pertaining to what crops they will produce in the upcoming cropping season.

In the case of beans, the focus of this paper, the performance of the bean market in Malawi in terms of integration and the flow of price information is crucial in enhancing the supply of beans by farmers to the national market. If markets are well integrated then information on any surplus or shortage in one market will be fully transmitted to other markets, thus keeping overall supply and demand of beans in the country balanced. If markets are not well integrated, then local scarcities of beans will emerge, since distant markets that might supply beans to local markets facing a shortage will not supply beans, since they did not have information, communicated through price signals, concerning the increased demand in the markets facing bean shortages. Moreover, if it is found that markets are not spatially or inter-temporally integrated, this could be indicative of and exacerbate market concentration and collusion with insufficient competition in local bean markets of Malawi, which results in distortions in the national bean market.

The majority of smallholder farmers do not have direct access to market information on the flow of goods between markets or on relative prices for those goods in local markets across Malawi. Without such information, producers are unable to engage in informed, profitable trade and derive real economic benefits from doing so. Despite the fact that price information is publicized through the radio and newspapers by the Ministry of Agriculture, the most common source of market information to farmers and traders in Malawi are social networks, i.e., friends, fellow businessmen, and relatives (SARRNET 2007). Incomplete transmission of information on market prices arises from excessive transaction costs, information access costs, the costs of conducting business negotiations, and domestic policies, like minimum prices, export bans, and the role of ADMARC in marketing agricultural commodities. All these limit the information farmers have and distort their marketing decisions. As such, agricultural market integration is an important determinant of the extent to which farmers and traders can profitably engage in commercial agriculture in a country like Malawi. Testing the degree to which markets for a particular commodity are integrated is crucial in determining the degree to which agriculture price policies should feature in strategies for national agricultural development.

The study of market integration involves determining the co-movements of prices and the transmission of price signals and information across spatially separated markets. Market integration ensures that a regional balance occurs between food-deficit and food-surplus areas (Chirwa 2001). Market integration can also be defined as a measure of the extent to which demand and supply levels in one location are transmitted to another location (Negassa, et al. 2003). To be able to efficiently design good market policies, policy makers need sufficient understanding of the functioning of markets, how well prices integrate across markets, and how those factors relate to changes in the institutional and policy environment of markets.

In view of this, this study assessed the degree of market integration and price relationships among local bean markets in Malawi and the role of transaction costs in influencing price transmission between them. Common beans were chosen as the commodity for study since the majority of smallholder farmers grow beans for both consumption and sale. The majority of bean consumers in Malawi rely on the market to get beans, hence the marketing performance of the crop has always been of particular concern to the government of Malawi (Kambewa 1997).

1.1 The importance of beans in Malawi

Beans are a primary source of protein for most Malawians as animal or fish protein is relatively expensive. Common bean (*Phaseolus vulgaris L.*) provides essential amino acids to human beings. Bean is high in the amino acid, lysine, which is relatively deficient in the staple carbohydrate food crops of Malawi, like maize, rice and cassava (Mwale et al. 2008). The potential yield of common bean in Malawi is 2,000 kg per hectare under researcher management, but most farmers realize yields much less than this – an average of 381 kg per ha (FAO 2008). Beans are ranked second to groundnuts among the legume crops in terms of area planted and quantity produced in Malawi. Globally, bean production and usage is increasing slowly, with highest usage in developing countries, where beans are a source of low-cost protein (Ferris and Kaganzi 2008).

Several factors constrain the production of common bean under smallholder farm conditions in Malawi. The most important of these are recurrent droughts, insect pests, disease, and lack of seed of improved varieties (Chirwa and Aggarwal 2001). In consequence, there is inadequate supply of the crop to meet the country's demands. In Africa common bean production is concentrated in ten countries, with Kenya as the leading producer followed by Uganda and Tanzania. Malawi is on position eight (FAO 2008). In Malawi, the choice of beans in the market is strongly influenced by consumers' familiarity with particular varieties and by grain color, which is usually associated with cooking time and taste (Chirwa et al. 2006).

1.2 Smallholder marketing of beans

Smallholder bean marketing in Malawi is plagued by a lack of market information, which affects farmer's production decisions. Hence, bridging the information gap between traders and farmers is crucial to ensure proper linkages between production and markets. The bean marketing channel comprises producers, middlemen, traders, exporters, and processors. Traders are mainly large scale buyers who buy beans for retail in local markets and for wholesale purposes. These traders buy from farmers and middlemen and, subsequently, sell to processors and exporters. They sometimes employ local people or buy from small middlemen within the community. The bean value chain is dominated by a few trading companies who do not play an active role in bean marketing and in the flow of bean market information. According to Chirwa et al. (2006), traders usually do not share market information about the most popular bean types for fear that producers would demand higher prices for their commodity.

There is high demand for beans produced in Malawi, both locally and internationally, but production is insufficient to meet demand (USAID 2009). Beans produced in Malawi are sold in the informal market for local domestic consumption (Katungi et al. 2009). Besides individual consumers, there is high demand for beans in institutions like prisons, hospitals and schools. The current deficit in common beans in the country indicates an apparent failure of the local bean market to stimulate production. Low and unstable prices as a result of seasonal nature of sales, lack of market information, and variable demand by traders reduces farmers expected returns. Hence, farmers invest little in bean production. However, demand for beans in the country is expected to continue to increase generally due to escalating prices of alternative sources of protein, such as fish and beef.

Cross-border bean trade has been growing in the region, with Malawi mostly being a net importer. Currently, Malawi imports common beans from Mozambique, Zambia, and Tanzania through informal channels (Katungi et al. 2009). However, there is also potential to export common beans to South Africa and the European market, but the capacity to exploit this potential is low. Among African countries, only Ethiopia has managed to export beans to European markets because of its low cost of production relative to its competitors (China and Canada) and its locational advantage. According to Alemu and Seifu (2003), improvements in farmgate prices following liberalization reforms in mid-1990s in Ethiopia encouraged private traders to export common bean.

This paper is organized as follows. Section 2 reviews the existing literature on co-integration methods and the empirical evidence from studies that have applied different integration methods. Section 3 discusses the empirical approaches used for the study here on common beans in Malawi. Section 4 presents the results with discussion. Section 5 concludes the paper.

2. THEORETICAL OVERVIEW OF AGRICULTURAL COMMODITY MARKET ANALYSIS

2.1 Market integration

Market integration for many agricultural commodities has been studied for insights into the functioning of agricultural produce markets. Such studies provide valuable information about the dynamics of market adjustments and whether there exist market imperfections that may justify government intervention (Sopo 2008). Some of the problems in agricultural marketing can be diagnosed through the use of the market integration analysis (Rashid et al. 2010). For example, if the costs of transporting a commodity from one market to the other are lower than the market margins, it may indicate a lack of market information flow or trade barriers. On the other hand, if the transportation costs are higher between two markets than other nearby markets, it may suggest that there is imperfect competition in the transport sector or poor road networks. Two methods are commonly used to measure market integration – the parity bound and threshold autoregressive approaches. Each takes into account the role of transaction costs in influencing prices.

In spatial terms, the Law of One Price (LOP) and market integration provide the basis for standard spatial price determination models. LOP is useful in determining the size of a market, predicting price changes within a market and evaluating the pricing efficiency of a market (Kohls and Uhl 1998). Under LOP, it is hypothesized that price transmission is complete when the equilibrium prices of a commodity sold to integrated markets differ only by the transfer costs for the commodity between the two markets. Changes in demand and supply in one market will affect the trade and prices in other markets in order to restore price equilibrium through spatial arbitrage. Therefore, incomplete transmission or inadequate market information of price changes in one market to another has important implications for economic welfare. Incomplete transmission of price information can be due to excessive transaction costs, such as those associated with negotiation, supervision, and transport; incomplete information; or to domestic policies, such as minimum prices, marketing boards, or price interventions. Incomplete information flows between international markets can arise from border policies, such as non-tariff barriers; import quotas; or export subsidies. All these impede the benefits of arbitrage between markets, distorting the marketing decisions of bean producers and bean traders. The LOP does not hold under such conditions (Ghafoor and Aslam 2012).

Assuming prices for a specific commodity in two spatially separated markets are P_{1t} and P_{2t}, respectively, the LOP suggests that at all points in time, if a transfer cost C is allowed to move the commodity from market 1 to market 2, the relationship between the prices is given as follows:

$$P_{1t} = P_{2t} + C \quad (1)$$

If such a relationship holds between the two prices in the two markets, the two markets are said to be integrated and the prices are in equilibrium. That is, a commodity will flow from market 1 to market 2 if the price in market 2 is higher than the price in market 1 with the difference being more than the cost of transporting the commodity from market 1 to market 2. With increased supply of the commodity to market 2 from market 1, prices in market 2 will fall back to being in equilibrium with prices in market 1, the benefits from trade will cease, and the flow of commodities will end.

Several studies have applied a parity bound model (PBM) to account for transaction costs in time series. However, due to some weaknesses in the PBM approach, some improvements have been made on the model, which has led to the introduction of the Threshold Autoregressive Models for market integration analyses. The threshold autoregressive model (TAR) is relatively simple to specify, estimate, and interpret. It also allows the researcher to differentiate between the speed of adjustment of market prices and transaction costs in different markets (van Campenhout 2007). In contrast to the PBM, the TAR model operates without directly relying on transaction costs data, which may not have been measured accurately or may not be available at all. The model estimates a threshold in the price margin between two markets below which trade is not profitable and we do not expect co-movement of prices. Above this threshold, trade is profitable and we expect co-movement of prices.

Under the TAR method, the process of market integration is broken into two components: transaction costs and the speed of price adjustment (van Campenhout 2007). Access to market information is more likely to influence the speed of adjustment than the transaction costs. For example, the use of modern Information and communication technologies, e.g., mobile phones and internet, might increase the speed of adjustment without significantly affecting transaction costs. Transaction costs are affected by transport costs and other risks associated with trade between markets.

However, the TAR method has two main weaknesses. First, it assumes that transaction costs remain constant throughout the study period (Balke and Fomby 1997). The constant transaction cost assumption may not be reasonable for countries like Malawi, where poor road conditions, especially during the rainy season, affect the flow of beans between markets and cause seasonal changes in transaction costs. The other weakness is that the asymptotic distribution of the threshold parameter is neither normal nor nuisance parameter free, hence it is impossible to obtain standard errors and confidence intervals (van Campenhout 2007).

2.2 Agricultural commodity market integration – empirical evidence

Several studies have been done on market integration in Eastern and Southern Africa using different methods. Korir et al. (2003) used bivariate correlation coefficients to study the performance of bean marketing between northern Tanzania and Kenya by measuring the degree of market integration between regional markets. The study identified a problem of lack of adequate information within the cross-border bean marketing system. Cross-border bean marketing is still largely informal in the two countries. The regional markets are weakly integrated with bean prices in deficit markets jointly interacting to inform bean prices in surplus markets.

To assess the effectiveness of modern information and communication technologies (ICT) based market interventions in improving maize market efficiency in Malawi, Tione (2011) applied co-integration error correction models. The study used a TAR Error Correction model to assess the speed of price transmission in pre-ICT and post-ICT periods. Spatial integration results showed that ICT-based market interventions positively influenced market integration and price transmission in maize markets in Malawi. It was concluded that modern ICTs have contributed to the reduction of search transaction costs, leading to improved marketing efficiency.

Uchezuba (2005) studied market integration for apples in South African fresh produce markets to determine the existence of long-run price relationships and spatial market linkages. The study revealed a statistically significant decline in real prices after deregulation in six of the eight markets under investigation. The study further found that the variation in real apple prices also declined in five of the eight markets after deregulation. To determine whether transaction cost has significant effects in measuring market integration, standard autoregressive and TAR error correction models were compared. The TAR model was shown to estimate faster price adjustments than did the standard autoregressive model – the TAR model required less time for one-half of the deviation from equilibrium to be eliminated.

Alemu and Biacuana (2006) applied the threshold autoregressive model to measure the extent of market integration in Mozambican maize markets. Specifically, they were looking at market integration between major surplus and deficit maize markets. They found that threshold values, i.e., estimates of transaction costs, were found to be correlated positively with the distance between two markets and inversely with the condition of the roads connecting the markets. Out of the four surplus and deficit market combinations studied, only two pairs were integrated – the Chimoio-Maputo and Mocuba-Nampula market pairs. However, the strongest degree of integration was between Chimoio and Maputo markets. The results from the impulse response analysis also revealed that it takes relatively less time for shocks introduced in the integrated markets to be eliminated compared with those market combinations that were shown to not be integrated, e.g., Chimoio-Beira and Ribáuè-Nampula.

Mayaka (2013) employed the TAR model to measure the extent of dry bean market integration between surplus and deficit markets in Kenya for the period 1994 to 2011. The study focused on four markets: Nairobi, Nakuru, Eldoret, and Kitale. The results showed that all markets were co-integrated. Only one market link, Kitale-Nairobi, showed bidirectional causality. The results showed that it took approximately three weeks for a shock in Nairobi to be transmitted to Kitale market. Therefore, the study concluded that improving marketing infrastructure like roads and communication facilities would increase the degree of market integration and reduce transaction costs in Kenyan dry bean markets.

3. STUDY METHODOLOGY

The study analyzed bean market prices using the TAR model for nine markets across Malawi – Chitipa, Rumphi and Mzuzu in the northern region; Mitundu, Lizulu and Lilongwe for the Central region; and Luchenza, Bangula and Lunzu in the Southern region. The rural markets studied represent some of the major beans producing areas of Malawi, while the urban markets – Mzuzu, Lilongwe, and Lunzu – are found in major consumption areas. The study used secondary data, the monthly price data in the Agricultural Market Information System (AMIS) database which is managed by the Ministry of Agriculture and Food Security (MoAFS) and covered the period 1995 to 2011. The study used the real prices of beans, as opposed to nominal prices, in order to account for changes that may have occurred or may be occurring in the value of the Malawi Kwacha over time as a result of inflation. The food CPI was used to correct for changes in the value of the Kwacha, making year-to-year comparison feasible and meaningful (CPI year 2000=100). Real prices were calculated by dividing the nominal prices by the price index for the same period in time. Seasonal variations and trend analysis were done to show the general direction of prices over the study period. To come up with a seasonal price index, the data for each month was expressed as percentages of monthly trend values. The required seasonal index was found by calculating the average of the percentages for corresponding months.

3.1 Threshold autoregressive (TAR) error correction model

The standard co-integration based test of market integration has been criticized on the premise that the results obtained are inconclusively drawn due to the omission of transaction costs (McNew and Fackler 1997; Barrett 1996). To overcome the problem of transaction costs, this study applied the TAR error correction model. Threshold co-integration is based on the assumption that the presence of transaction costs, which are unobservable, creates a “neutral band” within which prices in different markets are not linked (Balke and Fombly 1997; Goodwin and Piggott 2001; Goodwin and Harper 2000).

The standard linear autoregressive error correction model can be expressed as follows

$$P_{it} = \beta P_{jt} + \eta_t \qquad (2)$$

where P_{it} is the retail price of a given quantity of a commodity at time t and at location i, P_{jt} is the retail price of a given quantity at time t and at location j, β is the parameter to be estimated, and η_t is the error term, *iid* ~ N(0,σ).

The term η_t is used to define the error correction model since integration of P_{it} and P_{jt} depends on the behavior of η_t. That is, η_t is referred to as the deviation between prices in two different markets. When $\beta = 1$, the deviation η_t becomes non-stationary, leading to no integration between price series. Therefore, co-integration depends on the autoregressive behavior of the deviation of η_t (Uchezuba 2005).

Assuming that η_t from equation (2) follows a threshold autoregressive behavior, spatial price transmission in long-run equilibrium under competitive behavior is given as follows:

$$|P_{it} - P_{jt}| < c \qquad \text{if } q = 0 \text{ (Regime 1)} \qquad (3)$$

$$P_{it} - P_{jt} = c \qquad \text{if } q > 0 \text{ (Regime 2)} \qquad (4)$$

$$P_{it} - P_{jt} = -c \qquad \text{if } q < 0 \text{ (Regime 3)} \qquad (5)$$

where P_{it} is the price in market i at time t, P_{jt} is the price in market j at time t, and q is the quantity of commodity traded between the markets (Myers 2008). If $q > 0$, the commodity is traded from market i to j. If $q < 0$, the commodity is traded from market j to i. c is the marginal transfer cost and is assumed to be symmetric irrespective of the direction of trade flow.

The first regime occurs when there is no trade between markets. Hence the absolute value of the price spread should be less than the transfer cost. The second regime implies that if trade flows from i to j, then the price in j market should be at least equal to the price in i plus transfer cost. The third regime indicates that if trade flows from j to i, then the price in i market should be at least equal to the price in j plus the transfer cost (Myers, 2008).

Following Myers (2008) to test these regimes, the following threshold autoregressive error correction models were used:

$$\Delta\eta_t = \alpha + \beta_o\eta_{t-1} + \sum_{k=1}^{K}\beta_k\,\Delta\eta_{t-k} + \varepsilon_t \qquad \text{If } |\eta_t| \leq C_t \text{ (Regime 1)} \quad (6)$$

$$\Delta(\eta_t - C_t) = \alpha(\eta_{t-1} - C_{t-1}) + \sum_{k=1}^{K}\alpha_k\,\Delta(\eta_{t-k} - C_{t-k}) + \varepsilon_t \qquad \text{If } \eta_t > C_t \text{ (Regime 2)} \quad (7)$$

$$\Delta(\eta_t + C_t) = \alpha(\eta_{t-1} + C_{t-1}) + \sum_{k=1}^{K}\alpha_k\,\Delta(\eta_{t-k} - C_{t-k}) + \varepsilon_t \qquad \text{If } |\eta_t| < C_t \text{ (Regime 3)} \quad (8)$$

where $\eta_t = P_{it} - P_{jt}$ is the price spread between the markets at period t, Δ is the difference operator $\Delta\eta_t = \eta_t - \eta_{t-1}$, C_t is the long run transfer cost at t, and ε_t is the zero mean serially uncorrelated error term.

The TAR error correction model can be derived in a straightforward manner if price spread and transfer cost data are observable. However, if the data do not have transfer costs as separate data, an auxiliary model is used for long run transfer costs, c_t, which captures trends and variations over time. The long run transfer cost threshold can be presented as follows:

$$C_t = \delta_0 + (\delta_1 - \delta_0)\frac{t}{T-1} + \delta_2 P_{it} \qquad (9)$$

where t is the time index t = 0, 1, 2, ..., T is the total number of price observations, and P_{it} is the price in market i at time t.

If $\delta_2 = 0$, then δ_0 is the long run transfer cost at the beginning of the sample and δ_1 is the long run transfer cost at the end of the sample, after allowing for a linear time trend. The price variable of market i (P_{it}) is included to allow for the fact that some marginal transfer costs may vary with the price of the product.

For regimes 2 and 3, if $\alpha < 0$, there is a long run equilibrium relationship between η_t and C_t, and the size of α determines the spread of adjustment of the price spread back to the parity bound. Furthermore, when $\alpha = -1$ and $\alpha_k = 0$ for k= 1, 2,.., K would imply immediate adjustment, although the price spread never moves systematically outside the parity bound. For values of α between 0 and -1, the closer α is to 0, the slower the adjustment. While the closer α is to -1, the faster the adjustment. If the adjustment is fast, it implies more effective spatial price transmission.

Although the value of α gives the rate of price adjustment, it does not show the value of the adjustment. Therefore, a measure that helps interpret the spread of adjustment of price spreads back to the parity bound in regimes 2 and 3 is referred to as the half-life (h),

$$h = ln(0.5) / ln(\alpha - 1) \qquad (10)$$

When there is a supply or demand shock that raises price spread above the parity bound, the half-life is the time it takes for trade to increase and drive the price spread halfway back to the parity bound. This assumes there is no other shock within the period of adjustment. The shorter the half-life, the more effective is price transmission (Myers 2008).

4. RESULTS AND DISCUSSION

The nine selected markets for this study are spread across wide distances. Mzuzu, Lilongwe and Lunzu are categorized as urban markets and are located in mostly consuming areas. The other six markets are located in bean production areas. Descriptive analysis was done using the nominal bean prices in order to understand the data. Spatial integration analysis was done using monthly real bean retail price data valued in Malawi Kwacha (MK). In Malawi, agricultural production is mostly done in one season since the country experiences a unimodal annual rainfall pattern. Unit root test was done to determine the order of economic integration for each price series using the ADF test. The price series in levels were non-stationary, hence the data was differenced to make it stationary.

4.1 Descriptive statistics

Understanding price variability is important as it gives an insight of price behavior within the study period. Price variability can be a result of natural factors, such as weather variability, or economic factors, such as the structure of the market, e.g., transport costs, the number of market agents involved, and the length of different marketing channels. The highest nominal prices were observed in Lilongwe in June 2010, while the lowest nominal price was reported in Mitundu in May 1996 (Table 1). The higher prices in Lilongwe are a result of high urban demand for the product and the transaction costs incurred by traders when moving the product from producing areas, like Mitundu and Lizulu, to Lilongwe market. Prices in Mitundu and Chitipa markets are low because these markets are located in important bean growing regions of the country. Chitipa is a highland region well known as a surplus bean area. The low bean prices in Chitipa also may be related to the inflow of beans from neighboring Tanzania and Zambia. The bean prices reported in the rural Bangula market are higher than expected, but can be explained by low production there as a result of low rainfall in the Lower Shire Valley (Jere 2007). High prices in Bangula can also be attributed to floods which have affected the area. Moreover, Bangula is a border town and may experience high demand for beans from consumers in neighboring Mozambique. However, all the markets studied show high variability of prices over the years reflecting variability in bean production, primarily.

Table 1—Descriptive statistics of nominal monthly bean prices for study markets, 1995 to 2011, MK/kg

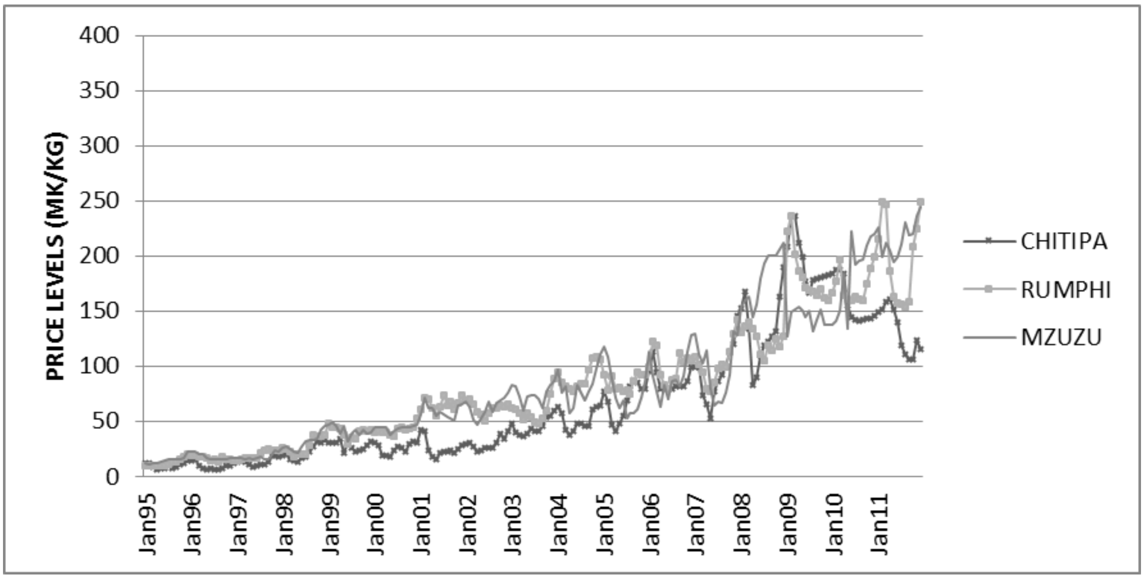
Market	n	Minimum	Maximum	Mean	Standard Error	Coefficient of Variation (%)
Chitipa	204	6.44	236.60	66.34	4.04	87.1
Rumphi	204	9.24	249.24	82.33	4.10	71.1
Mzuzu	204	11.40	244.86	84.11	4.35	73.9
Lilongwe	204	9.38	372.81	112.30	6.12	77.8
Mitundu	204	5.29	238.44	63.73	3.96	88.7
Lizulu	204	7.57	225.00	68.09	4.37	91.8
Lunzu	204	8.81	253.08	83.79	4.58	78.1
Luchenza	204	10.22	264.00	81.48	4.61	80.8
Bangula	204	7.86	291.43	93.67	5.46	83.2

Source: Author calculations from AMIS database of MoAFS

4.2 Price trends and seasonality

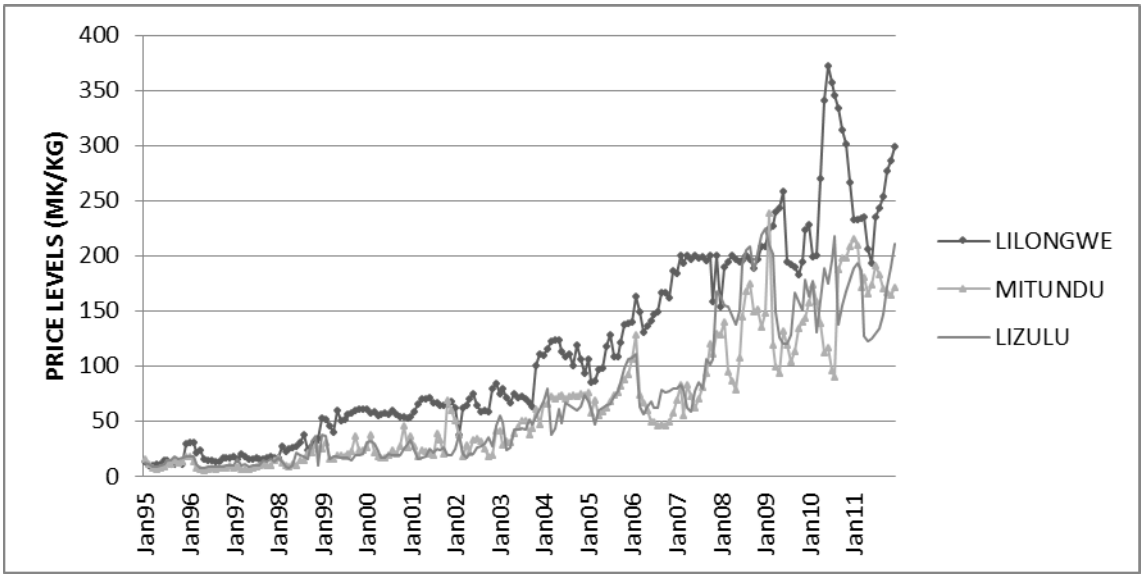
Graphical methods help identify trends, cycles or seasonal patterns in time series price data (Tomek and Robinson 1990). Agricultural commodities exhibit annual variability in their price series, principally because supply is concentrated during certain periods of the year corresponding to harvest seasons. Knowing seasonal price variations and trends also helps us better understand what is happening with demand and supply of beans on the market. Figures 1, 2, and 3 show graphs of nominal bean prices in the nine study markets. Prices in the three figures generally move in the same direction (co-move).

Figure 1—Bean price series, nominal prices, 1995 to 2011, Northern region



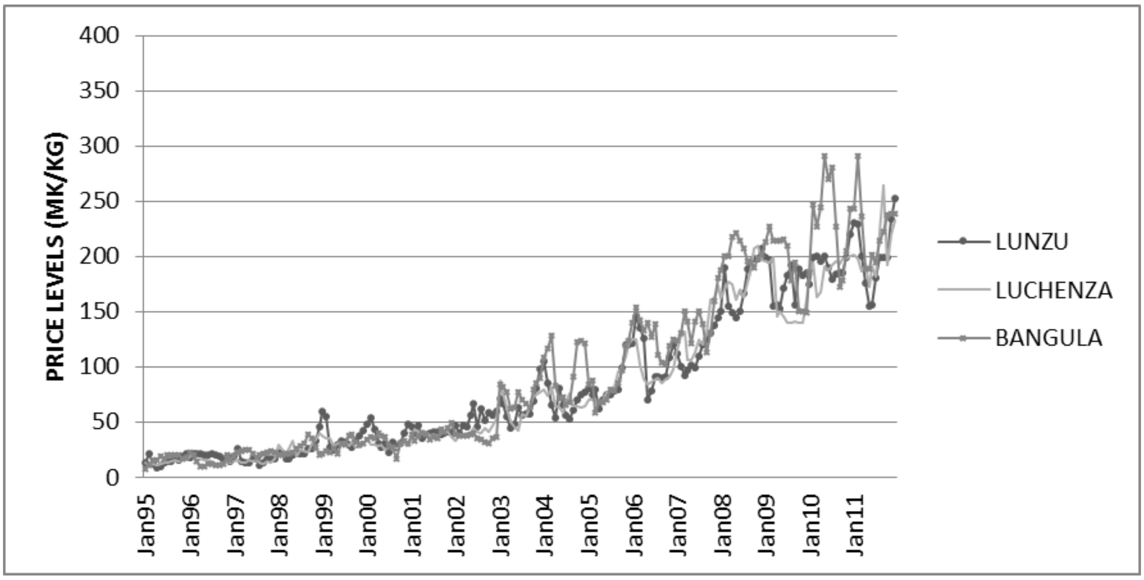
Source: Author calculations from AMIS database of MoAFS

Figure 2—Bean price series, nominal prices, 1995 to 2011, Central region



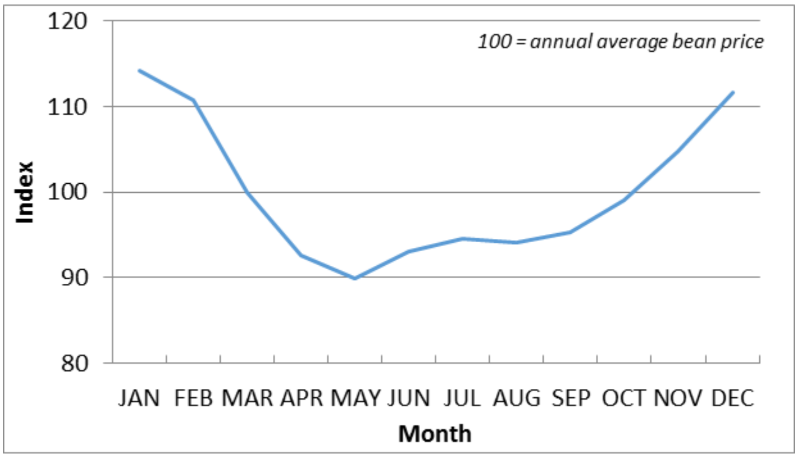
Source: Author calculations from AMIS database of MoAFS

Figure 3—Bean price series, nominal prices, 1995 to 2011, Southern region



Source: Author calculations from AMIS database of MoAFS

Figure 4—Bean Price Index by month



Source: Author calculations from AMIS database of MoAFS.
An index value for a month of 80 percent, for example, means that prices for that particular month are 20 percent lower than the annual average. Similarly, an index of 110 percent means that the price for that month is 10 percent higher than the annual average price (Goodwin, 1994).

Figure 4 shows the seasonal pattern of bean prices across the country. Seasonality occurs over the annual production cycle. As the marketing year progresses, crop prices follow a general seasonal pattern which is a function of relative changes in supply and demand. Generally crop prices are low at harvest in the months of April and May as fresh bean comes on the market. Prices rise during the post-harvest season. This is because of the cost of crop storage and because the supply of the crop is fixed and consumption gradually uses up the supply, causing prices to rise. The rainy season starts in December, the period of highest prices as the supply of beans is low during this period.

4.3 Price adjustment (standard autoregressive and TAR methods)

For markets to be integrated, certain conditions must be fulfilled. There must be free flow of goods between markets, and the markets must be linked by efficient arbitrage. Efficiency in spatial market arbitrage will cause the price risk to be spread amongst markets. That is, higher prices in deficit regions will be transmitted to surplus markets, and lower prices in the surplus regions will be transmitted to deficit markets. By this process, the prices in the markets will equalize through arbitrage. In the analysis here, both standard autoregressive and TAR error correction models are used since studies based on the co-integration test alone have been criticized since they do not account for transaction costs. The standard autoregressive model restricts the investigation of spatial price transmission as it fails to allow for a zone of inactivity when the price spread falls below a threshold that reflects the transfer cost between markets. Hence, to further analyze symmetrical price adjustment, the threshold autoregressive model was used and the results were compared to the standard autoregressive model. The aim is to compare results from the two models to determine whether transaction costs have a significant effect on measuring market integration. The thresholds indicate the amount by which the prices in the alternate markets should increase to trigger symmetric or asymmetric adjustments.

Eight market pairs which showed Granger causality were used in the analysis of AR and TAR models. Co-integration itself cannot be used to make inferences about the direction of causation between the variables and the causality tests are necessary. Granger causality identifies the direction of price formation between two markets and related spatial arbitrage, i.e., the physical movements of the commodity to adjust for these price differences. Causation can occur in two ways – bidirectional, where shocks in either market of a market pair are transmitted to the other market; and unidirectional, where shocks in one market affect another market, but not the reverse. Granger causality tests were applied for all market pairs of the three regional consumer market centers, Lilongwe, Mzuzu and Lunzu. Out of the resultant 21 market pairings, only eight showed Granger causality. Seven market pairs are related in a unidirectional way, while only one market pair, Mzuzu-Chitipa, is related in a bidirectional manner (Table 2).

Table 2—Granger causality tests by regional market centers

Market *i*	Market *j*	β*i*	*Pi*-value	β*j*	P*j*-Value	Direction
Lilongwe	Mzuzu	0.183	0.789	0.034	0.440	Independent
	Rumphi	0.389	0.598	0.055	0.102	Independent
	Chitipa	0.878	0.282	0.017	0.555	Independent
	Mitundu	-0.179	0.010 **	0.070	0.137	Unidirectional
	Lizulu	-0.165	0.063 *	0.040	0.327	Unidirectional
	Lunzu	-0.041	0.699	0.051	0.215	Independent
	Luchenza	0.173	0.110	0.114	0.001 ***	Unidirectional
	Bangula	0.217	0.001 ***	0.040	0.372	Unidirectional
Mzuzu	Rumphi	0.146	0.021 **	0.055	0.211	Unidirectional
	Chitipa	-0.150	0.030 **	-0.074	0.053 *	Bidirectional
	Mitundu	-0.023	0.694	-0.003	0.968	Independent
	Lizulu	0.037	0.621	0.068	0.201	Independent
	Lunzu	0.022	0.807	0.092	0.087 *	Unidirectional
	Luchenza	0.064	0.482	0.063	0.162	Independent
	Bangula	0.091	0.111	-0.061	0.298	Independent
Lunzu	Rumphi	-0.021	0.721	-0.026	0.705	Independent
	Chitipa	0.020	0.717	0.005	0.936	Independent
	Mitundu	0.097	0.130	-0.092	0.339	Independent
	Lizulu	0.050	0.942	0.115	0.162	Independent
	Luchenza	0.184	0.031 **	0.095	0.172	Unidirectional
	Bangula	0.048	0.363	-0.004	0.966	Independent

Source: Author calculations from AMIS database of MoAFS. Figures in parentheses are standard errors.
Note: Values with asterisks (*) show Granger causality. Significance level: *** (p ≤0.01); ** (p ≤0.05); * (p ≤ 0.10).

The results from Table 3 for the standard autoregressive and TAR error correction tests for the eight market pairs showing Granger causality indicate that the fastest significant price adjustment is observed in the Lunzu-Luchenza market pair. In the standard autoregressive model, the adjustment factor was 0.1021, which implies a half-life of 6.4 weeks or that it will take 6.4 weeks subsequent to the price shock for prices to return to half of the equilibrium price when transaction costs are not considered in estimating the speed of price adjustment. In the TAR model for the Lunzu-Luchenza market pair, the significant adjustment factor was 0.1061, which implies a half-life of 6.2 weeks. Our results show that simple standard autoregressive models always underestimate the speed of adjustment between markets relative to the estimates provided by the TAR error model. The standard autoregressive model estimates imply that it will take longer for an increase in the price margin to disappear than does the TAR error model. Van Campenhout (2012) suggests that this is due to the standard autoregressive model not appropriately reflecting the non-linear price adjustments created by the transaction cost band.

Table 3—Standard autoregressive and TAR error correction tests results for bean market pairs demonstrating Granger causality

Market pair	Distance (km)	Standard autoregressive model		Threshold autoregressive (TAR) error correction model		
		ρ	Half-life (weeks)	δ	ρ	Half-life (weeks)
Lilongwe-Mitundu	30	-0.014 (0.0480)	50.6	0.28	-0.057 (0.0075)	11.9
Lilongwe-Lizulu	158	-0.009 (0.0548)	75.0	0.18	-0.009 (0.0075)	73.4
Lilongwe-Luchenza	358	-0.060 (0.0540)	11.1	1.12	-0.064 (0.0153)	10.4
Lilongwe-Bangula	488	-0.083 (0.0632)	8.0	1.32	-0.107 (0.0175)	6.1
Mzuzu-Rumphi	68	-0.010 (0.0698)	67.6	1.46	-0.087 (0.0094)	7.6
Mzuzu-Chitipa	327	-0.046 (0.0571)	14.6	0.81	-0.064 (0.0086)	10.4
Mzuzu-Lunzu	676	-0.033 (0.5413)	20.5	6.15	-0.041 (0.0034)	16.4
Lunzu-Luchenza	47	-0.102 (0.5634)	6.4	3.03	-0.106 (0.0085)	6.2

Source: Author calculations from AMIS database of MoAFS. Figures in parentheses are standard errors.
Note: ρ denotes the adjustment parameter on the lagged price difference. δ denotes the estimated thresholds, expressed as a percentage of the mean price in the two markets.

According to the results of the TAR model, the estimated transaction cost for the Lunzu-Luchenza market pair was 3.0 percent of the mean prices in the markets. This suggests that the price adjustment speed will be estimated to be faster using the TAR model than the standard autoregressive model. This is because the TAR model considers the threshold where there is no price adjustment. TAR models are appropriate for estimating price adjustments between markets, particularly in developing countries since longer distances and poor infrastructure lead to high transaction costs (Abdulai 2000). It is also interesting to note that the price adjustment between the Lilongwe-Bangula market pair as estimated using the TAR model is the fastest of all of the eight market pairs examined, despite the fact that Lilongwe is quite far away from Bangula. This result is difficult to explain, as there is no reason for the two markets to be closely linked. Bangula primarily serves consumers in southern Malawi (Lunzu consumer market) and not Lilongwe and central Malawi.

The very low threshold value identified for the Lilongwe-Mitundu market pair could be attributed to the short distance separating the two markets. In contrast, the high value for the Lunzu-Luchenza market pair (3.03) is more difficult to explain, as these two markets in the southern region are relatively well connected by good roads. The Mzuzu-Lunzu market pair has an estimated transaction cost of 6.15 percent of the average price of beans in the two markets. The high threshold value for the Mzuzu-Lunzu market pair reflects the high transaction costs faced by traders due to the long distance between the two markets. This agrees with Alemu and Biacuana (2006), who observed that transaction costs are found to be higher in distant markets and in markets connected by poor roads. Improving transport infrastructure and information services can reduce transaction costs, thereby improving market efficiency and participation. In addition, the use of modern ICTs can also help to improve market efficiency as it reduces the transaction costs, as observed by Tione (2011).

5. CONCLUSION AND RECOMMENDATIONS

This study focused on market integration in nine local bean markets across Malawi. Time series data for the period January 1995 to December 2011 was used for the analysis. The results show that markets are integrated in the country as the private marketing system for beans is capable of smoothing spatial price variations in the long-run. The results show that in the long-run prices of beans in the spatially separated markets in Malawi have tendencies to move in the same direction. This shows that bean price transmission occurs between markets in Malawi.

However, the markets are not yet fully integrated. The estimates from the simple autoregressive model suggest that there is need to consider transaction costs when measuring market integration. The study results show that most of the markets in Malawi are not fully integrated with each other and there is inadequate flow of information between markets.

It is recommended that development of market information centers where farmers can access market information in their local areas is very important, since markets often are separated by long distances. Market information obtained will be important for price formation and will help enhance market integration and efficiency. There is need to enhance infrastructure development to improve market efficiency by reducing transaction costs. The distance to the market significantly affect pricing decision by farmers, therefore infrastructure developments like roads and establishing local markets within reach of farmers will motivate farmers to participate in the marketing of the beans they produce and at the same time ensure efficient flow of information between markets. Market information systems should also consider collecting more data on market prices from all markets in Malawi. There is a lack of market price information for most markets, including major consumer markets like Blantyre. There is also a need to extend the scope of the data collection to include information on transaction costs associated with trade flows between markets.

Further research should be done on the same crop or other crops by applying actual transaction costs data, since the current study was based on constant transaction costs. This may include data on the costs of transportation, negotiation, and acquiring price information. Future research may also consider including more markets to see the flow of price information, since this study only involved nine markets. Moreover, the study here used price data from 1995 to 2011 to account for the liberalization of markets, while a future study could compare the period before and after market liberalization in the 1980s and 1990s.

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Acknowledgments

This paper was selected for the Malawi Strategy Support Program (MaSSP) "Bunda Grant Scheme" for 2013/14. Under this capacity building program IFPRI provides financial and supervisory support to students to extract a journal-length article from their MSc theses. The author would like to thank Mariam Mapila and Todd Benson for guidance in this regard.

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This Working Paper has been prepared as an output for the Malawi Strategy Support Program, and has not been peer reviewed. Any opinions stated herein are those of the author(s) and do not necessarily reflect the policies or opinions of IFPRI.