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FOOD MARKETING REFORMS AND INTEGRATION OF MAIZE AND RICE MARKETS IN MALAWI

Abstract

Food marketing reforms in Malawi were part of the World Bank and International Monetary Fund (IMF) sponsored structural adjustment programs which were first implemented in 1981. Food marketing reforms were initiated in 1987 with the liberalisation of trading in smallholder agricultural produce, which the Agricultural Marketing and Development Corporation (ADMARC) monopolized. The government also liberalised prices of all food crops, except maize which is still subject to limited control and binding to ADMARC. This study tests whether the Law of One Price (LOP) holds for maize and rice spatial markets in Malawi using cointegration techniques in testing the spatial market integration hypotheses. The results suggest that markets for both rice a crop with complete price liberalization are more integrated than markets for maize in which the governments still imposes a price band for ADMARC. The exogeneity tests show that Blantyre and Karonga are markets that drive prices of other markets for maize and rice, respectively.

Keywords: Food Marketing Reforms, Market Integration, Malawian Agriculture

1. Introduction

Liberalisation of agricultural marketing services has been part of a World Bank/IMF package of economic reform to developing countries within the Structural Adjustment Programs (SAPs). The argument by the Bretton Woods institutions has been that the agriculture sector in developing countries is inefficient due to various state interventions with respect to marketing, pricing and various forms of input subsidies. Such policies have not provided proper incentive to smallholder farmers, and this has led to insufficient production of food crops. Many countries in the developing world, particularly in Africa, have liberalised the marketing of agricultural produce.[1] Malawi adopted structural adjustment programs in 1981 after the economic crisis of 1979 through to 1981. Since 1981 Malawi has had seven Structural Adjustment Loans (SALs). The government has embarked on reforms in the agricultural sector within a broader macro-adjustment programme with specific policy actions targeting marketing and pricing in the agriculture sector (Chirwa, 1998).

[1] Some notable examples in Africa include Zimbabwe, Zambia, Malawi, Ethiopia, Tanzania, Zambia and Somalia. There exist vast literature on the issue of food marketing liberalisation in Africa (see Dadi et al, 1992; Beynon et al, 1992; Coulter and Golob, 1992; Seppala, 1997; Chirwa, 1998; Rikuni and Wyckoff, 1991; Barrett, 1997; Jones, 1996; Santorum and Tibaijuka, 1992).

The study of market integration is important in order to determine 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. This study focuses on the integration of maize and rice markets in nine spatially separated markets using price information. Maize is the main staple food and rice is the alternative staple food in Malawi. Maize is mainly grown in the central region, while rice is mainly grown in the lake districts of northern, central and southern regions. The government maintains limited intervention on maize pricing while market forces completely determine the pricing of rice. We organise the rest of the paper as follows. Section 2 briefly reviews developments in food marketing policies in Malawi in the post-independence era. In Section 3 we present and review the various approaches of testing market integration. Section 4 reports and discusses the empirical evidence on market integration in maize and rice markets. In section 5, we offers concluding remarks and policy implications.

2. Food Marketing Policies and Reforms in Malawi

Prior to food marketing liberalization in 1987, state intervention in marketing of agricultural crops in Malawi were in the form of monopsony power of the state marketing agency, the regulation of private traders, and price controls. The state marketing agency, the Agricultural Development and Marketing Agency (ADMARC), had monopsony power in the purchase of two main cash crops from smallholder farmers, cotton and tobacco, under the Agricultural and Livestock Marketing Act of 1964. Otherwise, private trade in other commodities produced by smallholder farmers preceded official marketing institutions and has always been acceptable.[2] The only restrictions formally applied to the activities of large and non-African traders, including upper limits on quantities of produce a single trader may purchase. Nonetheless, most food crops were

[2] Scarborough (1990) argues that although ADMARC had limited monopsony power, private trade in other crops had been very effectively discouraged through alternative means, such as multiple licensing and red tape in the licensing of traders.

under marketing control and required one to obtain a license to conduct trade.[3] Moreover, private traders had to obtain separate licenses for the right to purchase each separate class of produce.

The government officially determined prices for all food crops under control by announcing pan-territorial and pan-seasonal prices which were binding to ADMARC. Chirwa (1998) observes that the private market price for maize was generally higher than the official price administered by ADMARC even during price controls, an indication that government pricing policy was not particularly binding to private traders. The government used ADMARC marketing activities as instruments of enforcing price policy in the agricultural sector and the wage-earning sector, particularly for maize.[4]

Reforms in agricultural marketing commenced in 1987, following the inefficiencies in the state marketing agency, ADMARC, deteriorating terms of trade in agricultural exports and the macroeconomic problems that adversely affected parastatal finances. The agricultural marketing reform programme was based on two strategies. First, in the short-term periodic price adjustments of smallholder crop prices provided an interim solution to the problem. Second, introduction of competition by allowing more players in the marketing of smallholder crops provided a long term solution. The price incentive strategy was based on the assumption that smallholder farmers are responsive to price signals to expand their production and to improve their productivity within a land constrained environment.

The legislation of the Agriculture (General Purpose) Act of 1987 essentially eliminated ADMARC's quasi-monopsony power in smallholder agriculture marketing in the domestic market. Regulations governing the activities of private traders in a liberalised market system had the following features: market-specific annual traders' licenses; restrictions on nationality;[5] pan-

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[3] The following crops were under price control and trader licensing requirement: burley, beeswax, black gram, bulrush millet, Canadian wonder beans, capsicums (dried), cashew nuts, cassava, castor, chilies (dried), chick peas, delicious beans, dried peas, green gram, groundnuts, honey, macadamia nuts, maize, mixed beans, paddy rice, pigeon peas, sesame, sorghum, soya beans, sugar beans, wheat and white haricot beans.

[4] Kandoole et al. (1988) and Harrigan (1988) elaborate on the pricing and storage policies that were supposed to be achieved, and the resultant conflicts.

[5] This was in line with the restriction of Asian and European traders in retail and wholesale businesses in rural areas effected by the amendment of the *Business Licensing Act* in 1975.

seasonal minimum producer prices; export licensing system for maize exports; traders' monthly submission of statements of trading activities. The government also decentralised the licensing of private traders to Agriculture Development Divisions (ADDs). This decentralisation reduced the red-tape in the licensing process. Although, marketing of agricultural produce is liberalized, ADMARC continues to play a dominant role through its extensive marketing network (1200 markets in 1987) in the urban and rural areas across the country.

In 1995, the government embarked on agricultural pricing reforms and abandoned the system of pan-territorial and pan-seasonal pricing for agricultural produce. ADMARC was free to determine the prices of all smallholder produce except for maize producer price in which it is allowed to vary prices within a fixed price band which is reviewed regularly. The government monitors the prices of various agricultural produce in various markets through collection of monthly prices from private traders in fifteen spatially separated markets. Although, the price information is important, the monitoring system does not determine the extent of trade flows between markets and the number of private traders that actively operate in various markets.

Following these reforms, several studies have evaluate the supply response to liberalisation of smallholder agriculture marketing activities in Malawi and highlight the problems and constraints that private traders face in marketing activities (Kaluwa, 1992; Kaluwa and Kandoole, 1989; Kaluwa et al, 1990; Kaluwa and Chilowa, 1991; Kandoole et al, 1988; Mkwezalamba, 1989, Scarborough, 1990; Chirwa, 1998). The main constraint faced by private traders include transport availability and transport costs, credit availability, storage facilities and lack of pricing and marketing skills. Goletti and Babu (1994) investigate the integration of maize markets and use monthly retail prices of maize at eight main locations between 1981 and 1991, and find that liberalization increased market integration and that the major urban areas were pivotal in the price transmission.

3. Testing Market Integration

3.1 Concept and Measurement

The concept of market integration is modelled within the framework of the spatial price equilibrium (SPE) model of inter-market linkages, in the point-space tradition of Samuelson (1952) and Takayama and Judge (1964), that is subject to production shocks and general price information. Two markets may be said to be spatially integrated if, when trade takes place between them, price in the importing market equals price in the exporting market plus the transportation and other transfer costs involved in moving food between them. When transfer costs equal the inter-market price differential and if there are no barriers to trade between markets, trade will cause prices in the two markets to move on a one-for-one basis and the spatial arbitrage conditions are binding. Testing whether the arbitrage conditions are met requires information on prices, trade flows between markets and transfer costs. However, in empirical work only price information is readily available, and empirical tests of market integration concentrate on price analysis. Barrett (1996) notes that co-movements of prices has thus become synonymous with market integration.

The literature suggests several approaches to testing spatial market integration using market prices to examine the concept of spatial arbitrage and the effect of liberalization of food marketing systems in developing countries.[6] The conventional tests of market integration, when only price series data is available, include correlation analysis following Jones (1972) and Lele (1967), the Law of One Price (Richardson, 1978), the Ravallion model (Ravallion, 1986), and the application of new econometric techniques of cointegration and Granger causality (Palaskas and Harriss-White, 1993; Alexander and Wyeth, 1994). These traditional methods based on price information only have been criticized in the literature.[7] Baulch (1997b) notes that these tests ignore transfer costs and assume a linear relationship between market prices, not consistent with discontinuities in trade implied by the spatial arbitrage conditions.

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[6] See among others Jones (1972), Silvapulle and Jayasuriya (1994), Palaskas and Harriss-White (1993), Jones (1996), Alexander and Wyeth (1994), Fafchamps and Gavian (1996), Baulch (1997 a, b) and Barrett (1997).

[7] See Barrett (1996), Timmer (1996) and Baulch (1997a,b).

New developments in testing spatial market integration include the parity bounds approach (Baulch, 1997a; Fafchamps and Gavian, 1996), which provides a continuous measure of the frequency of profitable trade opportunities. However, the parity bounds model requires information about transfer costs between markets, which is rarely available in developing countries. Empirical studies using the parity bounds model rely on best estimates of transaction costs and the model falls short of telling us whether trade flows occur (see Barrett, 1996). Zanias (1999) also notes that using proxy transport costs or transaction costs may create more problems than they intend to solve. Timmer (1996) also observes that in spite of sophistication in econometric techniques our understanding of market integration requires real data on transaction costs and trade flows between spatially separated markets.

Nonetheless, in the absence of data on transaction costs, testing the LOP and Ravallion models based on cointegration analysis is still popular (Asche et al. 1999; Zanias, 1999). Given that only price information is collected in Malawi, we test the Law of One Price based on cointegration analysis in this study. Besides, government intervention in marketing and pricing of agricultural produce were intended to smooth price variability for food security, in a way imposing an artificial unified market system.[8] The test of market integration based on price information will shed light on whether after various policy reforms in agricultural produce marketing we can establish that prices move within a fixed band in the long-run.

3.2 The Law of One Price and Cointegration Analysis

The Law of One Price (LOP) captures the existence of a spatial competitive equilibrium due to the efficient commodity arbitrage between two or more trading markets. The LOP assumes that if market are integrated, price changes in one market will be transmitted on a one-for-one basis to other markets instantaneously. The most common expression for the LOP is

$$p_t^i = \alpha + \beta \, p_t^j \tag{1}$$

[8] Chirwa (1998) using data from private traders between 1988 and 1995, however, shows that spatial price variations for maize were on average 25.3 percent above the mean while those for rice were only 15 percent above the mean price.

where p_t^i and p_t^j are the natural logarithm of prices of homogeneous goods in market *i* and *j*, respectively. The LOP in its strict form requires that $\beta=1$ and $\alpha=0$. Empirically only $\beta=1$ is tested and the constant term is assumed to account for transport and other transfer costs which are assumed to be proportional to prices (or constant when prices are in levels) during the period of analysis. In empirical work, the Law of One Price is tested by running the following regression

$$p_t^i = \alpha + \beta\, p_t^j + \varepsilon_t \qquad (2)$$

where ε_t is the error term. This tests whether equation (2) reduces to equation (1) by testing the null hypothesis that $\beta=1$. New developments in time-series econometrics, suggest that if the price series are non-stationery, normal inference is not valid on the parameters and results from equation (2) are spurious. However, if the price series are integrated of the same order, then equation (2) can be used to test for cointegration using either the Engle-Granger two-step procedure or the Johansen Vector Auto Regression (VAR) method. The advantage of the VAR procedure is that it avoids the simultaneity problem and allows hypothesis testing on the cointegration vector.

Cointegration implies that there is a linear long-run relationship between price series in spatially separated markets, and is interpreted as a test that $\beta\neq0$. Thus if $\beta\neq0$, the price series are cointegrated and a long-run equilibrium relationship exists between the prices, and hence there exist a cointegration vector (1, -β). Therefore, cointegration tests for market integration are only tests of whether there is a statistically linear relationship between different data series (Asche et al, 1999). However, Barrett (1996) argues that while cointegration indicates that a long-run reduced form linear relationship exists between two time series, it is neither a necessary nor a sufficient condition for market integration. In any case, cointegration tests for more general notion of equilibrium.

The Johansen VAR based procedure (Johansen, 1988) of testing cointegration is the maximum likelihood procedure which relies on the relationship between the rank of a matrix and its characteristic roots. The Johansen (Trace) test detects the number of cointegration vectors that exists between two or more integrated time series. The Johansen procedure can be used to test for the presence of a cointegration vector between different price series if they are integrated of the same order. The procedure is based on maximum likelihood estimation of the error correction model and each two-variable system is modelled as a vector auto regression (VAR)

$$x_t = \mu + \sum_{i=1}^{k-1} \;_i\, x_{t-i} + \quad x_{t-k} + \varepsilon_t \qquad (3)$$

where x_t is an $n \times 1$ vector containing the series of interest (spatial prices), and are the matrices of parameters, k is adequately large both to capture the short-run dynamics of the underlying VAR and to produce normally distributed white noise residuals and ε_t is a vector of white noise errors. The Johansen methodology involves testing whether the matrix in (3) has less than full rank using the maximal eigenvalues test and the trace test. The rank of , r, determines the number of linear combinations of x_t that are stationary. If $r = n$, the variables in levels are stationary and if $r = 0$ then none of the linear combinations are stationary. When $0 < r < n$, there are r cointegration vectors or r stationary linear combinations of x_t. $=\alpha\beta'$, where both α and β are $n \times r$ matrices, with β containing the cointegration vectors and α containing the adjustment parameters. We test the LOP by imposing the restriction that $\beta' = (1, -1)$ on pairwise cointegrated vectors.

3.3 Weak Exogeneity

The Johansen procedure also allows a range of hypothesis testing on the coefficients α and β using the likelihood ratio test.[9] One such test relates to the exogeneity of price series in the system. If we have two spatial prices, p_t^i and p_t^j, the price p_t^i is weakly exogenous to p_t^j if p_t^i is tested to be weakly exogenous and p_t^j is not weakly exogenous to p_t^i. This implies that p_t^i is causing p_t^j to change and not vice-versa. The test for exogeneity involves testing the factor loading matrix, α, that contains information about the dynamic adjustment of the long-run relationships (Asche et al, 1999). It is important to test whether some market prices influence the movements of prices in other markets in the long-run. This is a test of weak exogeneity and tests whether prices in market *i* are weakly exogenous to market *j* (or all other markets in the system) by testing the restriction that all parameters in the corresponding row in the α matrix are zero.

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[9] I am grateful to an anonymous referee who suggested that the causality approach in the earlier version of the paper should be based on the VAR procedure focusing on the test for weak exogeneity.

4. Data and Empirical Analysis

The Ministry of Agriculture and Livestock Development collects monthly price data for various crops from more than fifteen spatial markets across the country. We use data collected between 1989 and 1998 in the analysis. The data are mainly collected from small scale traders mainly involved in domestic flow of agricultural produce competing with the state marketing agency. Kaluwa (1992) and Mkwezalamba (1989) observe that most private traders are small-scale entrepreneurs (sole proprietors) with rural-based enterprises and highly diversified in the number of crops traded. Large scale enterprises are mainly purchase agricultural produce for exports or for industrial processing.

Although the government monitor price developments across the country, most of the markets for which data are available are urban or district centres which are well linked, hence price developments in the rural and remote areas are not known. The other aspect which is neglected in the food markets monitoring system is the data on transaction costs and trade flows or the extent of the mobility of private traders (to indicate the categorical flow of produce between markets) which would enrich our understanding of the integration of markets.

Our test for the market integration hypothesis is based on nine selected spatial markets in the three regions of the country, one commercial centre (a regional administrative centre) and two rural or district markets in each region. The study explores the integration of the following markets: Chitipa, Karonga and Mzuzu in the northern region; Nkhotakota, Lilongwe and Lizuli in the central region, and Blantyre, Luchenza and Bangula in the southern region. Mzuzu, Lilongwe and Blantyre are the three regional cities in Malawi. Figure 1 shows the selected markets and the distance between them.

[Figure 1 about here]

All the prices are in natural logarithm of Malawi Kwacha per kilogram. The nine spatial markets lead to thirty-six market interrelationships. We first test for the presence of unit roots in the data series in natural logarithm using the Augmented Dickey-Fuller (ADF) test following Dickey and Fuller (1979) using TSP version 4.4 (see Hall, Cummins and Schnake, 1995). Our test of market integration utilizes a multivariate approach to investigate whether the selected markets operate as a unified market and test for exogeneity to the system, and a bivariate approach to test pairwise market integration and exogeneity. The estimates were obtained using PcFiml 9.10 (see Doornik and Hendry, 1997).

Table 1 present descriptive statistics and unit root tests for maize and rice prices in nine spatial markets. On average the regional centres Blantyre, Mzuzu and Lilongwe exhibit higher nominal prices for rice as major demand centres while Bangula, Karonga and Nkhotakota exhibit lower prices as major producing areas of rice in Malawi. With respect to maize, Blantyre, Nkhotakota and Mzuzu exhibit higher average prices while Bangula, Chitipa and Lizuli exhibit lowest average prices. However, in both maize and rice markets, the variation in prices is quite high and in most cases the standard deviation is more than the mean prices.

[Figure 2 and Figure 3 about here]

The natural logarithm of spatial prices for maize and rice are plotted in Figure 2 and Figure 3, respectively. Generally, there is an upward trend in the prices of both maize and rice over time although there are short-run deviations. However, in the case of rice the fall in the nominal price is also apparent from the end of 1996 to the beginning of 1998. This fall in the prices may be partly attributed to the increase in the smallholder production of rice by 86 percent in 1996, prompted by better prices in the previous year, followed by a marginal fall of 10 percent in 1997 (Malawi Government, 1997).

[Table 1 about here]

The augmented Dickey-Fuller (ADF) test statistics for stationarity of price series in the nine markets for maize and rice are reported in Table 1. The results indicate that we accept the null hypothesis of non-stationarity against the alternative of stationarity in both maize and rice price series, suggesting that prices are not integrated of order zero. Thus, the price series in levels contain a unit root. However, after differencing the price series once the ADF test rejects the non-stationarity hypothesis for maize and rice prices in all markets at 1 percent significance level, implying that the price series are I(1).

Table 2 reports results of multivariate cointegration analysis for both maize and rice markets and The trace statistics indicates that there are eight cointegrating vectors in the rice market and only three cointegrating vectors in the maize market, significant at 5 percent level. The results show that both maize and rice markets operate as a unified market system, although market integration is stronger in rice markets whose pricing is completely liberalized than in maize markets in which the government imposes a fixed price band for producer price and imposes pan-territorial consumer prices on ADMARC.

[Table 2 about here]

We tested whether there is a single market that drives changes in the prices in other location by imposing restrictions on the α matrix. The tests for weak exogeneity in Table 3 show that the null hypothesis of weak exogeneity is not rejected with respect to Blantyre and Bangula markets for maize and with respect to Karonga for rice markets at 5 percent level. Prices in maize prices in other markets seem to be driven, in the long-run, by Blantyre and Bangula. Blantyre is a major demand centre for commercial maize while Bangula is a border town with Mozambique. Similarly, Karonga as a border market with Tanzania as well as the main production district of rice seems, in the long-run, to determine the movement of prices in other markets. The exogeneity of Bangula and Karonga markets imply that the gains from cross-border trade are transmitted to other domestic spatial markets. The test of whether the Law of One Price hold in the whole marketing network is accepted for maize and rejected for rice at 1 percent significance level.

[Table 3 about here]

Bivariate cointegration tests using Johansen procedure are reported in Table 4. The strength of market integration in rice markets compared to maize markets is also reflected in bivariate cointegration analysis. The results show that all rice markets are highly integrated, with thirty-four market links significant at 1 percent and two market links cointegrated at 5 percent significance level. Maize markets are only cointegrated in twenty-seven market links, with seventeen significant at 1 percent level and ten market links significant at 5 percent level. The weak exogeneity tests in the bivariate cointegration analysis also reveal that Blantyre is weakly exogenous to eight maize markets but cointegrated with only three of these markets. The border districts of Chitipa, Karonga and Bangula are exogenous to three, four and two maize markets, respectively. With respect to rice markets, Blantyre is exogenous to seven rice markets while the border districts of Karonga and Chitipa are exogenous to six and five markets, respectively. Apart from Blantyre other urban centres such as Mzuzu and Lilongwe - as regional high demand areas - do not seem to be driving forces in the prices of food products in rural or supply areas.

[Table 4 about here]

While the general notion of long-run equilibrium is strong particularly in rice markets, the test of whether the LOP holds in its strict form in the long-run shows that we can reject the null hypothesis of the LOP in eleven out of thirty-six market links in rice markets and only in one market link in maize markets. The results of the weak exogeneity tests in both multivariate and bivariate analyses enable use to model the price formation and short-run dynamics in single equation error correction models (ECMs). Since Blantyre for the maize price series and Karonga for the rice series are confirmed as exogenous markets in both multivariate and bivariate analysis, we investigate short-run price dynamics in other markets by assuming that Blantyre and Karonga are exogenous with respect to maize and rice markets, respectively. We estimate the following equation for each of the price series:

$$\ln p_t^i = \alpha_0 + \sum_{k=1}^{3} \quad _k S_k + \sum_{l=1}^{q-1} \alpha_l \quad \ln p_{t-l}^i + \sum_{l=0}^{q-l} \quad _l \quad \ln p_{t-l}^j + \quad ECT_{t-1} \quad (4)$$

where S_k are seasonal dummies (quarterly), p_t^i is the price of maize or rice in a dependent market i , p_t^j is the price of maize or rice in weakly exogenous markets (*j* = Blantyre for maize and *j* = Karonga for rice), ECT_{t-1} is the lagged error correction term. The most relevant parameters in equation (4) are the short-run parameter ($_0$) and the adjustment parameter ( ).

Table 5 presents error correction models for maize prices assuming that Blantyre prices are exogenous to other market prices.[10] Karonga, Nkhotakota and Lilongwe are the only maize markets in which seasonality seem to play a part since some of the seasonal dummies are

[10] We report results using a lag structure of six months, inclusion of higher lag terms did not improve the performance of the models and most of the parameters were not statistically significant.

statistically significant at 10 percent level. Prices tend to decline in the second quarter of the year which coincides with the harvesting season. The short-run parameters (the coefficient of p_t^j) are statistically significant at 10 percent level with respect to seven markets. The value of significant short-run parameters range from 0.16 for Nkhotakota to 0.42 in for Bangula. Higher values of the short-run parameter indicate that the price relationships do not deviate substantially from LOP in the short-run. We also observe lagged response of changes in the prices of maize in Chitipa, Mzuzu and Lizuli to changes in the price of maize in Blantyre. The adjustment parameters are statistically significant at conventional levels in six markets and the speed of adjustment towards the long-run equilibrium is slowest for maize prices in Mzuzu (-0.17) and fastest in Luchenza (-0.40).

[*Table 5 about here]*

The behaviour of rice prices is similar to that of maize prices. Table 6 presents the error correction models for rice prices assuming that Karonga prices are exogenous to all other markets. Prices for rice tend to be higher in the third and fourth quarter in most markets. This behaviour may reflect the nature of rice demand as a substitute for maize in the second half of the year in which maize reserves from previous harvest normally run down. The short-run parameters show that the price relationship do not deviate substantially from the LOP, with the value of the parameter close to one and ranging from 0.57 in the Bangula to 0.80 in Mzuzu. The contemporaneous change in Karonga prices significantly explain changes in the price of rice in other markets. Thus, the price increases in Karonga resulting from cross-border trade with Tanzania will immediately influence positive changes in the price of rice in other domestic market. Apparently, the lagged response to changes in rice prices in Karonga are only observed in the Chitipa equation. The adjustment parameters are statistically significant at 5 percent level in all equations and range from -0.24 in equation for Chitipa to -0.58 in the equation for Blantyre, and the negative values imply that positive deviations from the long-run equilibrium are corrected by decreases in prices in a particular market.

[*Table 6 about here]*

5. Policy Implications and Conclusions

The paper set out to investigate the integration of maize and rice markets by testing whether the Law of One Price holds in Malawi. The results, using cointegration techniques based on the vector auto regression approach, show that markets are highly integrated and the LOP is accepted in 97 percent and 69 percent of market links for maize and rice, respectively. Therefore, the results from testing the LOP as a long-run equilibrium relationship using cointegration show that in the long-run prices for both maize and rice in spatially separated markets in Malawi have a tendency to move within a fixed band. Although there are short-run deviations, the private marketing system is capable of smoothing spatial price variations in the long-run.

Tests for weak exogeneity show that generally Blantyre and Bangula for maize and Karonga for rice, based on the multivariate approach, are the main markets that drive the prices in other markets both in the multivariate. The bivariate analysis shows that Blantyre and Karonga are weakly exogenous in both maize and rice markets. Our results also shows that contemporaneous changes maize prices in Blantyre determine the movement of prices in seven other markets implying that a rise in demand in the commercial city is likely to have a positive impact in the prices in other districts and hence providing incentives for farmers in the supply regions. Rice prices in all eight other districts are strongly influenced by changes in rice prices in Karonga. The significance of prices in Karonga, which is both one of the main supply districts and the border town with Tanzania, implies that productivity gains and international prices will immediately be passed to other domestic markets.

In terms of government policy we weakly find high market integration in rice markets - one of the food products in which private marketing and pricing was liberal even before liberalization in 1987 - compared to maize markets where the government still maintains, through ADMARC, pan-territorial consumer prices and price band for producer prices. The difference in cointegration of maize and rice markets is not statistically significant. This suggests that official price for maize which is only binding to ADMARC does not significantly influence the long-run relationship of maize prices in spatially separated markets.

The high level of integration of markets may reflect either the efficient flow of information or the flow of produce between markets. The popularity of ‘day markets’, that involve traders moving from one market to another on different days of the week greatly facilitates the flow of information about prices of different products. Thus, although some markets are far apart, these day markets are unifying spatially separated markets. This is also reflected in the high cointegration of prices in a multivariate cointegration analysis. However, as observed above, the long-run relationships between market prices do not neccessarily imply movement of goods between markets.

The data unfortunately only captures the performance of markets that are major consumption centres and those that are well connected in terms of infrastructure, in which the government concentrates its price monitoring efforts. The locations which may be of main concern with respect to food security, particularly rural areas where ADMARC closed its markets, are given less attention in the government’s price monitoring initiatives. Our understanding of the performance of the private food marketing system can be enriched if government’s price monitoring efforts can be extended to rural markets and by extending the current scope of the data collection to include the quantitative or/and qualitative indications of trade flows between markets and the producer prices. The available evidence suggest that private traders in remote areas, partly due to high transport costs, offer much lower prices to producers and producers are subjected to unfair trading practices such as ‘adjusted’ measuring instruments (NEC, 1998). The current price monitoring mechanism is incapable of capturing these private food marketing problems.

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Table 1 Descriptive Statistics and Unit Root Tests: Maize and Rice Prices

Market	Maize Prices				Rice Prices			
	Mean	Standard Deviation	Augmented Dickey-Fuller (ADF)		Mean	Standard Deviation	Augmented Dickey-Fuller (ADF)	
			I(0)	I(1)			I(0)	I(1)
Chitipa	1.48	1.66	-0.201	-6.543	6.66	6.52	-2.845	-5.875
Karonga	1.81	1.93	-3.368	-6.462	6.20	6.81	-2.845	-6.590
Mzuzu	1.85	2.12	-2.362	-6.271	7.62	8.01	-2.650	-7.087
Nkhotakota	1.87	2.11	-2.818	-6.447	6.34	6.00	-2.842	-6.852
Lilongwe	1.77	2.23	-2.267	-7.101	7.06	7.40	-2.265	-6.462
Lizuli	1.57	1.99	-0.663	-6.217	6.61	8.50	-2.104	-6.752
Blantyre	2.01	2.59	-2.883	-6.990	7.86	8.61	-2.343	-6.538
Luchenza	1.92	2.48	-1.186	-6.769	6.25	6.10	-2.907	-6.668
Bangula	1.45	2.10	-2.538	-7.710	6.07	6.68	-3.032	-6.182
MacKinnon Critical Values								
1 percent level			-4.039	-3.488			-4.039	-3.488
5 percent level			-3.449	-2.887			-3.449	-2.887
10 percent level			-3.149	-2.580			-3.149	-2.580

Notes: The mean and standard deviations are based on absolute nominal price levels while unit root tests are based on the natural logarithm of nominal prices. The ADF test using a maximum of three lags with 120 observations in each case.

Table 2 Multivariate Johansen Tests for Maize and Rice

	Maize				Rice			
H_0: rank=r	Max Test	Critical Value 5%	Trace Test	Critical Value 5%	Max Test	Critical Value 5%	Trace Test	Critical Value 5%
r = 0	59.2[b]	57.1	241.7[a]	192.9	69.0[a]	57.1	302.7[a]	192.9
r ≤ 1	52.9[b]	51.4	182.5[a]	156.0	58.0[a]	51.4	233.7[a]	156.0
r ≤ 2	40.8	45.3	129.7[b]	124.2	49.6[b]	45.3	175.7[a]	124.2
r ≤ 3	29.8	39.4	88.8	94.2	37.0	39.4	126.1[a]	94.2
r ≤ 4	23.0	33.5	59.0	68.5	26.5	33.5	89.1[a]	68.5
r ≤ 5	19.0	27.1	36.0	47.2	24.2	27.1	62.6[a]	47.2
r ≤ 6	8.6	21.0	17.0	29.7	22.7[b]	21.0	38.4[a]	29.7
r ≤ 7	7.6	14.1	8.5	15.4	15.4[b]	14.1	15.6[b]	15.4
r ≤ 8	0.8	3.8	0.8	3.8	0.3	3.8	0.3	3.8

Notes: [a] Significant at 1 percent level, [b] Significant at 5 percent level

Table 3 Weak Exogeneity Tests for Maize and Rice

Potential Exogenous Market	Maize		Rice	
	Test Statistics	p-value	Test Statistic	p-value
CHIT	35.084[a]	[0.0000]	16.949[b]	[0.0306]
KARO	21.581[a]	[0.0058]	15.093	[0.0574]
MZUZ	24.544[a]	[0.0019]	49.838[a]	[0.0000]
NKHO	33.607[a]	[0.0000]	41.575[a]	[0.0000]
LILO	32.891[a]	[0.0001]	36.309[a]	[0.0000]
LIZU	24.989[a]	[0.0016]	21.466[a]	[0.0060]
BLAN	9.738	[0.2839]	28.543[a]	[0.0004]
LUNC	22.641[a]	[0.0039]	28.656[a]	[0.0004]
BANG	14.993	[0.0593]	21.216[a]	[0.0066]
LOP	9.884	[0.2733]	30.813[a]	[0.0002]

Notes: CHIT=Chitipa, KARO=Karonga, MZUZ=Mzuzu, NKHO=Nkhotakota, LILO=Lilongwe, LIZU=Lizuli, BLAN=Blantyre, LUNC=Luchenza, BANG=Bangula, [a] Significant at 1 percent level, [b] Significant at 5 percent level. The test statistic for weak exogeneity and LOP is the likelihood ratio test distributed as ^{2} with 8 degrees of freedom.

Table 4 Bivariate Johansen Tests and Weak Exogeneity Tests for Maize and Rice

	Market Links		Maize				Rice			
			Johansen Trace Test	Weak Exogeneity Tests		LOP	Johansen Trace Test	Weak Exogeneity Tests		LOP
	Market *i*	Market *j*	H_0: r = 0	Market *i*	Market *j*		H_0: r = 0	Market *i*	Market *j*	
1	CHIT	KARO	36.58[a]	23.62[a]	3.84	3.24	18.45[b]	6.32[b]	1.40	0.73
2	CHIT	MZUZ	15.79[b]	2.46	8.71[a]	1.71	42.97[a]	0.35	27.86[a]	0.05
3	CHIT	NKHO	17.36[b]	11.11[a]	3.21	2.36	29.64[a]	1.0E-3	17.42[a]	2.34
4	CHIT	LILO	29.02[a]	1.85	19.33[a]	0.49	23.92[a]	2.07	10.25[a]	2.0E-4
5	CHIT	LIZU	12.58	0.41	7.94[a]	0.91	12.27[a]	5.14[b]	7.02[a]	4.56[b]
6	CHIT	BLAN	13.72	8.91[a]	1.18	1.07	24.48[a]	7.64[a]	2.90	1.58
7	CHIT	LUNC	19.05[b]	7.94[a]	7.29[a]	4.0E-3	23.27[a]	3.46	6.69[a]	0.49
8	CHIT	BANG	13.54	5.22[b]	5.64[b]	0.18	20.11[a]	0.61	6.99[a]	3.73
9	KARO	MZUZ	31.53[a]	3.53	20.70[a]	1.78	36.27[a]	0.24	21.85[a]	0.68
10	KARO	NKHO	22.52[a]	8.75[a]	5.05[b]	0.73	20.95[a]	1.0E-4	11.74[a]	2.81
11	KARO	LILO	32.88[a]	1.53	25.23[a]	3.35	18.39[b]	1.07	6.43[b]	0.36
12	KARO	LIZU	18.51[b]	0.78	15.45[a]	0.09	23.64[a]	4.20[b]	9.24[a]	2.16
13	KARO	BLAN	10.84	5.72[b]	2.58	2.0E-4	29.12[a]	5.18[b]	5.79[b]	0.18
14	KARO	LUNC	22.59[a]	7.51[a]	10.76[a]	1.09	23.39[a]	1.23	8.35[a]	0.02
15	KARO	BANG	16.88[b]	5.69[b]	9.05[a]	0.05	20.11[a]	2.68	10.41[a]	1.19
16	MZUZ	NKHO	28.56[a]	14.91[a]	8.79[a]	0.12	33.57[a]	4.35[b]	8.63[a]	2.07
17	MZUZ	LILO	27.50[a]	8.32[a]	17.23[a]	5.24[b]	34.79[a]	5.57[b]	7.94[a]	0.02
18	MZUZ	LIZU	20.77[a]	3.28	10.09[a]	0.14	25.96[a]	8.55[a]	4.50[b]	5.01[b]
19	MZUZ	BLAN	13.37	7.36[a]	2.49	0.04	38.91[a]	19.51[a]	0.57	2.02
20	MZUZ	LUNC	21.55[a]	10.87[a]	9.42[a]	1.79	31.43[a]	10.02[a]	4.05[b]	0.45
21	MZUZ	BANG	25.20[a]	13.37[a]	7.75[a]	0.48	25.44[a]	9.25[a]	4.04[b]	3.97[b]
22	NKHO	LILO	25.46[a]	0.57	20.11[a]	3.77	21.96[a]	5.77[b]	0.68	1.42
23	NKHO	LIZU	18.77[b]	0.33	15.93[a]	0.11	34.17[a]	19.90[a]	0.16	13.82[a]
24	NKHO	BLAN	17.00[b]	10.85[a]	3.64	0.02	23.93[a]	16.65[a]	1.97	5.52[b]
25	NKHO	LUNC	25.45[a]	10.03[a]	8.64[a]	2.36	31.93[a]	12.25[a]	0.42	5.97[b]
26	NKHO	BANG	17.23[b]	5.44[a]	10.89[a]	0.47	27.84[a]	7.57[a]	4.53[b]	9.58[a]
27	LILO	LIZU	23.41[a]	7.84[a]	8.45[a]	3.06	30.18[a]	9.84[a]	2.16	8.50[a]
28	LILO	BLAN	13.36	9.37[a]	0.27	0.53	25.96[a]	13.98[a]	0.99	1.75
29	LILO	LUNC	21.55[a]	15.60[a]	1.63	0.02	24.96[a]	5.21[b]	1.36	0.6
30	LILO	BANG	18.41[b]	11.99[a]	3.76	0.48	22.78[a]	4.69[b]	4.72[b]	4.74[b]
31	LIZU	BLAN	14.85	10.26[a]	0.66	0.02	29.78[a]	11.03[a]	2.25	3.31
32	LIZU	LUNC	25.73[a]	18.65[a]	4.29[b]	1.25	34.20[a]	5.52[b]	13.93[a]	3.89[b]
33	LIZU	BANG	21.02[a]	13.41[a]	3.53	0.08	19.85[a]	2.46	10.11[a]	0.02
34	BLAN	LUNC	16.08[b]	1.06	11.81[a]	1.03	25.70[a]	0.12	8.93[a]	0.32
35	BLAN	BANG	11.78	1.18	6.97[a]	0.02	25.51[a]	0.68	13.26[a]	2.76
36	LUNC	BANG	15.32	6.56[b]	4.06[b]	0.19	27.08[a]	1.24	11.48[a]	4.47[b]
No. Int. Markets Links			27	-	-	-	36	-	-	-
No. Reject LOP			-	-	-	1	-	-	-	11

Notes: CHIT=Chitipa, KARO=Karonga, MZUZ=Mzuzu, NKHO=Nkhotakota, LILO=Lilongwe, LIZU=Lizuli, BLAN=Blantyre, LUNC=Luchenza, BANG=Bangula, [a] Significant at 1 percent level, [b] Significant at 5 percent level. The test statistic for weak exogeneity and LOP is the likelihood ratio test distributed as ^{2} with 1 degree of freedom.

Table 5 Error Correction Models for Maize Prices with Blantyre prices as exogenous

	Chitipa		Karonga		Mzuzu		Nkhotakota		Lilongwe		Lizuli		Luchenza		Bangula	
Variables	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*
constant	0.049	0.26	0.057	0.12	0.019	0.65	0.074	0.07	0.081	0.03	-0.021	0.65	-0.038	0.62	-0.044	0.49
Q2	-0.070	0.21	-0.178	0.00	0.014	0.80	-0.092	0.08	-0.113	0.02	-0.002	0.97	-0.041	0.70	0.051	0.55
Q3	-0.073	0.22	0.043	0.41	-0.017	0.76	-0.011	0.84	-0.085	0.09	0.015	0.82	0.115	0.32	0.057	0.50
Q4	-0.008	0.87	0.044	0.36	0.004	0.93	-0.025	0.56	0.000	0.99	-0.011	0.85	0.144	0.09	0.087	0.21
Δp^i, t-1	-0.402	0.00	-0.205	0.06	-0.166	0.17	0.032	0.79	-0.007	0.95	-0.088	0.49	-0.061	0.66	0.049	0.65
Δp^i, t-2	-0.290	0.03	-0.224	0.04	-0.197	0.10	-0.072	0.52	-0.051	0.64	-0.030	0.82	0.144	0.30	0.012	0.91
Δp^i, t-3	-0.271	0.03	0.117	0.32	-0.047	0.69	0.008	0.95	-0.092	0.40	-0.127	0.30	0.003	0.98	-0.033	0.75
Δp^i, t-4	-0.298	0.02	0.018	0.87	-0.161	0.16	0.144	0.19	-0.011	0.92	-0.204	0.10	0.037	0.75	0.017	0.86
Δp^i, t-5	-0.172	0.13	-0.028	0.77	-0.090	0.44	-0.082	0.41	-0.071	0.51	-0.090	0.44	0.022	0.86	0.083	0.39
Δp^i, t-6	-0.091	0.37	0.125	0.22	-0.162	0.11	0.049	0.62	0.173	0.10	-0.113	0.28	-0.072	0.48	-0.050	0.59
Δp^j, t	0.263	0.01	0.125	0.16	0.180	0.09	0.155	0.10	0.240	0.01	0.339	0.01	0.377	0.03	0.417	0.01
Δp^j, t-1	0.362	0.00	0.166	0.14	0.294	0.03	-0.046	0.69	0.076	0.52	0.495	0.01	-0.074	0.73	0.167	0.34
Δp^j, t-2	0.383	0.00	0.034	0.76	0.228	0.08	-0.101	0.36	-0.065	0.57	0.369	0.03	0.010	0.96	0.197	0.25
Δp^j, t-3	0.366	0.00	-0.035	0.74	0.117	0.34	-0.151	0.16	-0.047	0.67	0.301	0.06	0.002	0.99	-0.277	0.10
Δp^j, t-4	0.245	0.07	-0.122	0.25	0.087	0.48	-0.160	0.14	-0.043	0.70	0.223	0.16	-0.102	0.62	-0.061	0.73
Δp^j, t-5	0.158	0.20	-0.103	0.32	0.114	0.34	-0.025	0.81	-0.011	0.92	0.271	0.08	-0.066	0.74	-0.188	0.25
Δp^j, t-6	0.088	0.40	-0.135	0.14	-0.062	0.55	-0.229	0.01	-0.043	0.63	0.117	0.36	0.132	0.45	0.129	0.39
ECT, t-1	-0.106	0.23	-0.111	0.11	-0.172	0.06	-0.310	0.00	-0.193	0.01	-0.252	0.02	-0.403	0.00	-0.221	0.01
R^2	0.42		0.53		0.34		0.35		0.36		0.46		0.32		0.28	
F	3.99	0.00	6.25	0.00	2.89	0.00	3.06	0.00	3.12	0.00	4.84	0.00	2.60	0.00	2.26	0.01
N	113		113		113		113		113		113		113		113	

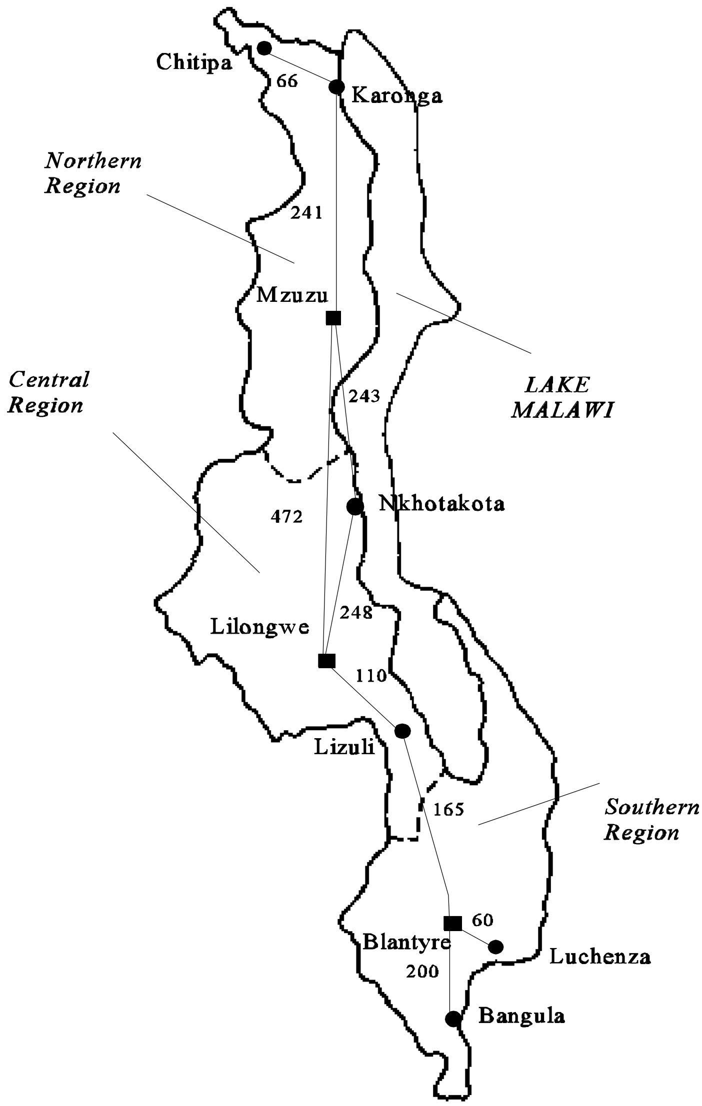
Notes: *coeff* stands for coefficient and *p-v* stands for the probability of rejecting the null hypothesis that the coefficient is equal to zero, F is the F-test of the null hypothesis that all coefficient are equal to zero.

Table 6 Error Correction Models for Rice Prices with Karonga prices as exogenous

	Chitipa		Mzuzu		Nkhotakota		Lilongwe		Lizuli		Blantyre		Luchenza		Bangula	
Variables	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*	*coeff*	*p-v*
constant	-0.039	0.41	-0.088	0.21	-0.049	0.43	-0.114	0.04	-0.105	0.11	-0.127	0.03	-0.112	0.04	-0.020	0.81
Q2	0.012	0.84	-0.031	0.72	0.015	0.84	0.014	0.83	0.041	0.61	0.062	0.35	0.095	0.16	0.020	0.84
Q3	0.122	0.08	0.178	0.08	0.109	0.24	0.246	0.00	0.229	0.02	0.224	0.01	0.206	0.01	0.171	0.16
Q4	0.016	0.80	0.117	0.23	0.094	0.27	0.157	0.04	0.202	0.03	0.202	0.01	0.147	0.05	-0.071	0.53
Δp^i, t-1	-0.240	0.10	-0.279	0.15	-0.132	0.42	-0.206	0.11	-0.129	0.34	-0.027	0.86	-0.028	0.86	0.102	0.45
Δp^i, t-2	-0.131	0.38	-0.239	0.20	-0.011	0.94	-0.037	0.76	-0.093	0.49	-0.091	0.55	0.153	0.27	0.213	0.10
Δp^i, t-3	-0.088	0.54	-0.202	0.25	-0.023	0.87	-0.020	0.87	-0.042	0.73	0.026	0.85	0.068	0.60	0.144	0.25
Δp^i, t-4	-0.081	0.56	-0.102	0.51	-0.006	0.96	0.036	0.75	0.072	0.53	0.050	0.70	-0.095	0.43	0.080	0.50
Δp^i, t-5	-0.105	0.40	-0.125	0.35	-0.102	0.45	0.070	0.52	0.054	0.61	0.110	0.38	-0.050	0.66	0.047	0.68
Δp^i, t-6	0.102	0.35	-0.195	0.07	-0.039	0.72	0.086	0.38	0.032	0.69	0.005	0.96	0.050	0.61	0.117	0.28
Δp^j, t	0.645	0.00	0.795	0.00	0.727	0.00	0.740	0.00	0.644	0.00	0.737	0.00	0.744	0.00	0.567	0.00
Δp^j, t-1	0.321	0.05	0.286	0.24	0.025	0.89	0.122	0.43	-0.008	0.97	-0.110	0.53	-0.021	0.90	-0.123	0.54
Δp^j, t-2	0.323	0.05	0.371	0.11	0.042	0.82	0.050	0.73	0.073	0.68	0.116	0.50	0.002	0.99	-0.062	0.75
Δp^j, t-3	0.171	0.29	0.431	0.05	0.060	0.74	0.077	0.59	0.091	0.57	0.066	0.68	-0.048	0.74	-0.015	0.94
Δp^j, t-4	0.057	0.70	0.268	0.18	-0.025	0.88	0.120	0.37	0.062	0.68	0.165	0.25	0.057	0.67	-0.132	0.42
Δp^j, t-5	0.007	0.96	0.250	0.17	0.058	0.71	0.176	0.17	0.035	0.80	0.043	0.76	0.060	0.64	-0.197	0.23
Δp^j, t-6	-0.150	0.15	0.299	0.04	0.110	0.40	0.117	0.30	0.089	0.46	0.172	0.12	0.040	0.72	-0.166	0.24
ECT, t-1	-0.235	0.04	-0.492	0.01	-0.390	0.01	-0.345	0.00	-0.398	0.00	-0.557	0.00	-0.480	0.00	-0.448	0.00
R^2	0.51		0.56		0.56		0.59		0.46		0.60		0.58		0.33	
F	5.71	0.00	7.07	0.00	7.03	0.00	8.06	0.00	4.79	0.00	8.38	0.00	7.77	0.00	2.73	0.01
N	113		113		113		113		113		113		113		113	

Notes: *coeff* stands for coefficient and *p-v* stands for the probability of rejecting the null hypothesis that the coefficient is equal to zero, F is the F-test of the null hypothesis that all coefficient are equal to zero.

Figure 1 Map of Malawi: Sketch of the Selected Spatial Markets



Notes: *This sketch is not drawn to scale and figures indicate the approximate road distance in kilometres between markets using the most direct route.*

Figure 2 Rice Prices from Nine Spatial Markets (in natural logarithm)

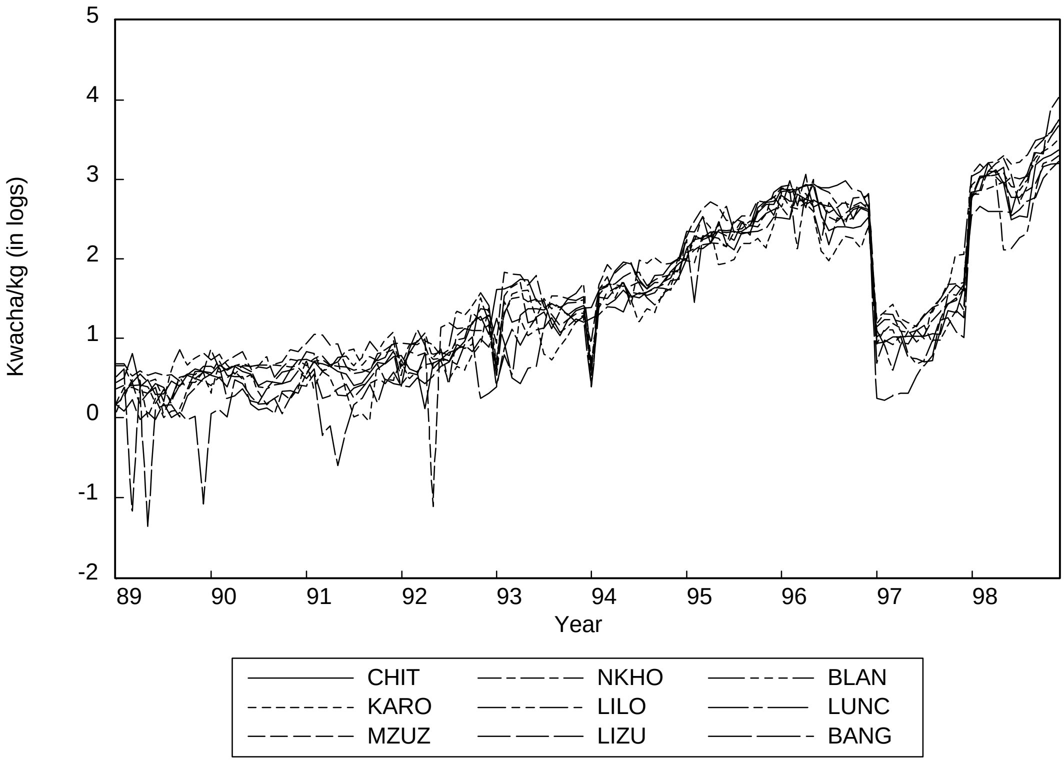


Figure 3 Maize Prices from Nine Spatial Markets (in natural logarithm)