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The Role of ICT-based Market Information Services in Spatial Food Market
Integration: The Case of Malawi Agricultural Commodity Exchange

By

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The Role of ICT-based Market Information Services in Spatial Food Market Integration: The
Case of Malawi Agricultural Commodity Exchange

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The Role of ICT-based Market Information Services in Spatial Food Market Integration: The Case of Malawi Agricultural Commodity Exchange

Abstract

The government of Malawi in 2004 initiated an ICT-based Malawi Agricultural Commodity Exchange (MACE), a market information service project, to improve access by farmers to market information. MACE was intended to improve the efficiency of agricultural markets as part of the strategy to improve food security. This study uses quantitative methods to examine whether MACE has contributed to efficiency of rice markets in Malawi. It especially tests if MACE has contributed to spatial integration of rice markets. As hypothesized, the study finds that the tendency of rice prices to move together in spatially separated markets has significantly increased since the implementation of MACE. It concludes that ICT-based market information services improve the efficiency with which agricultural markets perform. The study discusses implications of this finding for policy

Keywords: *ICT-based intervention, market information service, market integration, rice, Malawi*

1.0 INTRODUCTION

The government of Malawi has been pursuing policies aimed at attaining food self sufficiency for the last couple of years. The pursuit of these policies have been accelerated by the recent global food price inflation that saw food prices double in some countries and sparking food riots (Okello, 2009; Chirwa, 2009). Some of the factors attributed to the food price inflation in related to the poor domestic policies that penalized agricultural sectors include, bad weather, poor performance of agricultural markets, and lack of market information. However, the surge in prices in Malawi is no new phenomenon. There have similar food price increases in Malawi in 2001/02, 2005/06 and 2007/08 (Chirwa, 2009). Following the global, regional and national food price surge, Malawi government has strengthened its efforts to improve the performance of agricultural markets.

The Performance of agricultural markets is seen as crucial in attaining food security in Malawi. However, agricultural markets often tend to fail for smallholder farmers who form the majority of the agricultural producers (Barrett, 2009). For such farmers, the market tends to be thin, fragmented and missing altogether (Shiferaw et al, 2006). The failure of agricultural markets for smallholder farmers often result from lack of access to information or from the endemic problem of information asymmetry between the farmers and buyers (Kydd and Doward, 1889; Poulton et al., 2006). Consequently, majority of smallholder farmers sell their produce in local poor-paying markets or at the farm-gate rather than travel to distant better-paying markets (Fafchamps and Hill, 2005). Facilitating farmer access to better-paying markets has thus been an issue of major concern to policymakers in Malawi.

Food security can however also be attained when markets function efficiently and therefore facilitate trade between different regions. Trade between different regions facilitate movement of food from food-surplus areas into food-deficit areas. Thus the integration of food markets enhances regional food security by ensuring regional balance among food-deficit, food-surplus and non-food cash crop-producing regions. When, however, food markets are not integrated, local food scarcity will persist, as localized deficient markets fail to send the right signals to the surplus markets to attract supplies of food grains.

The government of Malawi has been pursuing several policy interventions aimed at improving agricultural market performance. These interventions include market liberalisation introduced in 1987 and the establishment in 2004 of the Malawi Agricultural Commodity Exchange (MACE) (Goletti and Babu, 1994; Phiri, 2006). MACE, an ICT-based MIS, was introduced to resolve the constraint of poor access to market information by farmers in order to strengthen the liberalised markets (Phiri, 2006). It was initiated to help smallholder farmers to access better markets and prices for their produce. The intervention was intended to spur improved performance of agricultural commodity markets by lowering transaction costs, improving market co-ordination and integration. Reduction in transaction costs was expected to arise from availability of price information and improving smallholder farmers' access to input and output markets (IDEAA,

2004). It was expected that through the dissemination of pro-poor market information, MACE would enhance market efficiency and competitiveness in the agricultural sector, enhance bargaining power of smallholder farmers in the market place and provide a fair market price discovery mechanism (Phiri, 2006). Has MACE been able to meet these expectations? This study examines the role MACE has played in promoting the integration of food markets in Malawi. It specifically analyzes the extent to which markets covered by MACE are integrated. It focuses on the rice markets. Rice is the second most important grain staple after Maize in Malawi. It has recently received attention as an alternative food crop in case of maize failure. The rest of this paper is organized as follows. Section 2 presents the study methods while Section 3 is the data. Section 4 presents the results and Section 5 concludes.

2.0 METHODOLOGY

The measurement of the extent of spatial market integration still has major challenges. Testing whether the arbitrage conditions are met requires information on prices, trade flows between markets and transfer costs (Uchezuba, 2005). However, only price information tends to be available. Consequently, majority of empirical tests of market integration use price. Barrett (1996) thus notes that co-movement of prices has become synonymous with market integration. However, this approach has one major weakness namely, does not reveal whether price differentials cause trade-flow reversals among markets or not.

The conventional tests of market integration, when only price series data are available, include correlation analysis and econometric techniques (Ravallion, 1986; Palaskas and Harriss-White, 1993; Alexander and Wyeth, 1994). Following Engel and Granger (1987), the co-integration model was specified, in this study, in two steps namely, non-stationarity test using the Augmented Dickey Fuller (ADF) test and co-integration analysis. We briefly discuss the two methods below.

2.1 Stationarity Tests of the Data

The data in this study were tested for non-stationarity using Augmented Dickey Fuller test (ADF), specified for any given price series as,

$$\Delta P_{it} = \alpha + \beta P_{it-1} + \delta T + \sum_{\gamma=1}^{k_i} \varphi_{\gamma} \Delta P_{it-\gamma} + \varepsilon_t \quad (1)$$

where T is the time trend and ΔP_t is the price difference ($P_t - P_{t-1}$).

The model can be estimated with or without a time trend (T) depending on the nature of the price series. The time trend term is only included to ensure that the apparent lack of stationarity is not due to the presence of a deterministic trend (Bopape, 2002; Dawson and Dey, 2002). The number of lags is given as k, and ε_t are assumed not to be autocorrelated. The lag length (k) was

determined using the Akaike Information Criterion (AIC). The null hypothesis assumes that unit roots exist (i.e. $H_0: \beta = 0$). Failure to reject the null implies the series is non-stationary and has to be differenced until it becomes stationary (i.e., $I(0)$).

2.2 Co-Integration Analysis

Co-integration among two non-stationary price series, for instance, implies that a linear combination of the two series is stationary and the prices therefore tend to move together or follow the same path in the long-run. If P_{it} denotes the price at market i at time t , and P_{jt} denote the price in market j at time t , the coefficient, β in (2) below gives the long-run relationship between these two markets only if the error term, ε_t is $I(0)$.

$$P_{it} = \delta_0 + \beta P_{jt} + \varepsilon_t \quad (2)$$

Thus co-integration between markets implies that $\beta \neq 0$ and there exists a co-integration vector $(1, -\beta)$. In this study we used the Johansen VAR-based procedure (Johansen, 1988) of determining $n - 1$ co-integrating vectors. We define P_t as a $n \times 1$ vector of non-stationary prices, where P_{it} denotes the price of rice at i th market at time t . The Engle-Granger representation theorem indicates that the vector autoregressive error correction form of P_t can be shown as,

$$\Delta P_t = \eta + \gamma t + \Pi P_{t-1} + \sum_{i=1}^{k+1} \Phi_i \Delta P_{t-i} + \varepsilon_t \quad (3)$$

where η and γ are vectors of constants and time trend coefficients, respectively; Π and Φ are $n \times n$ matrices of coefficients; k is the number of lags; ε_t is an identically and independently distributed n -dimension vector of residuals with zero mean and variance matrix, $\Omega \varepsilon$. If the vector P_t contains $I(1)$ prices, then the term $\Pi P_{t-1} \sim I(0)$. If the rank of Π is r , and $r < n$, then there exists $n \times r$ matrices α and β each with a rank such that $\Pi = \alpha \beta'$ and $\beta' P_t$ is stationary. The rank r determines the number of co-integrating vectors of P_t and the matrix Π is the one that conveys information about the longrun relationship among prices in the vector P_t (Ghosh, 2003). The hypothesis of co-integration is given as $H(r): \Pi = \alpha \beta'$. In this study we chose the trace test to determine the number of co-integrating vectors in Π . The trace statistic tests the null hypothesis of r co-integrating vectors against a general alternative hypothesis of more than r co-integrating vectors and is computed as,

$$\lambda_{trace} = -T \sum_{i=r+1}^n \log(1 - \tilde{\lambda}_i) \quad r = 0, 1, 2, \dots, n-1 \quad (4)$$

2.3 Granger Causality Tests breather

In order to assess the nature of rice price transmission across markets and causal relationships among spatially separated markets, the Granger causality test was performed. A price series P_{it} is said to Granger cause another price series P_{jt} if current and lagged values of P_{it} improve prediction of P_{jt} (Gujarati, 1995). Causality is a measure of the predictability of prices, that is, price movements in one market can be used to forecast price changes in other markets (Minten and Mendonza, 1998). Rashid (2004) argues that Granger causality can be tested within Johansen's co-integration framework. For a pair-wise causal relationship, equation (3) can be specified as:

$$\begin{bmatrix} \Delta P_{1t} \\ \Delta P_{2t} \end{bmatrix} = \begin{bmatrix} \eta_1 \\ \eta_2 \end{bmatrix} + \sum_{i=1}^{k-1} \begin{bmatrix} \varphi_{i,11} & \varphi_{i,12} \\ \varphi_{i,21} & \varphi_{i,22} \end{bmatrix} \begin{bmatrix} \Delta P_{1t-i} \\ \Delta P_{2t-i} \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} \begin{bmatrix} P_{1t-k} \\ P_{2t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad (5)$$

where number of subscripts denote markets 1 and 2. Causation can be tested in three ways; (i) uni-directional causality from P_{1t} to P_{2t} if $\alpha_1 = 0, \alpha_2 \neq 0$; (ii) uni-directional causality from P_{2t} to P_{1t} if $\alpha_2 = 0, \alpha_1 \neq 0$; (iii) bi-directional (feedback) between P_{1t} and P_{2t} if $\alpha_1 \neq 0, \alpha_2 \neq 0$.

2.4 Dynamic Interrelationships among Prices at Different Markets

Following Abdula (2005), the dynamic adjustments of the rice prices in the different markets were analysed to examine i) whether there is a shock in one rice market, how much of that shock will be transmitted to the other rice market, ii) how long it takes for a price shock in one market to be transmitted to another market. This was done by determining the degree of change (shock transmission) in the price of rice in a peripheral market following a change (shock) in the price of rice in a central market and the length of time taken for the change to be fully transmitted. The magnitude of the influence of changes in prices in one market and prices in other markets and the speed of adjustment to these changes can be measured to determine the strength (or weakness) of the market linkages and the sluggishness by which markets responds and adjust to shocks. Following Chirwa (2001), the study investigated shortrun (contemporaneous) and longrun (equilibrium) dynamics of rice prices using the error correction model. For any given rice price relationship between a peripheral and a central market, we have,

$$\Delta \ln P_{it} = \alpha_0 + \sum_{k=1}^3 \delta_k S_k + \sum_{l=1}^{q-1} \alpha_l \Delta \ln P_{it-l} + \sum_{l=0}^{q-1} \delta_l \Delta \ln P_{jt-l} + \theta ECT_{t-1} + \varepsilon_t \quad (6)$$

where S_k are seasonal dummies (quarterly); P_{it} is the price of rice in a given peripheral or dependent market i ; P_{jt} is the price of rice in a central or independent market j ; ECT_{t-1} is the lagged error correction term, ε_t is white noise. The parameters of interest were, (δ) , the one representing the contemporaneous (short-run) effect; and (θ) , the one indicating how quickly prices in the system react to any disequilibrium (speed of adjustment) or the error correction rate. The short-run and long-run adjustment parameters have implications for causality and co-

integration (Enders, 1995). If $\theta = 0$, then the change in P_{it} does not respond to the deviations (any discrepancy between P_{it} and P_{jt}) from the long-run equilibrium in the previous period ($t-1$). If $\theta = 0$, and all δ_i are zero, then P_{jt} does not Granger cause P_{it} . In addition, the price series are co-integrated if one or both of the coefficients are significantly different from zero.

3.0 THE DATA

The study focused on nine selected markets across Malawi where rice prices are collected by both the Ministry of Agriculture and Food Security and IDEAA Malawi. The markets studied were Chitipa, Karonga and Mzuzu in the northern region; Salima, Lilongwe and Chimbiya in the central region; Ntaja, Lunzu, and Bangula in the southern region. Selection of the markets was based on availability of the data and also aimed at national representativeness. Mzuzu, Lilongwe, Lunzu and Chimbiya are the major deficit markets. Chitipa, Karonga, Salima, Ntaja, Bangula are the surplus markets. Lilongwe, Mzuzu and Blantyre (Lunzu) are the three major urban (demand) centres in Malawi. The data were monthly rice prices from 1994 to 2007. The data were split into two sets; Pre-MACE (January 1994 – August 2004) and post-MACE periods (September 2004 – December 2007).

4.0 RESULTS

4.1 Stationarity Test

The price series from the nine selected markets of the study were tested individually for the presence of unit roots using the Augmented Dickey Fuller (ADF) test. The Akaike Information Criterion (AIC) was used to determine the lag length. The resulting residuals follow white noise process. Results of the ADF tests are presented in Table 1.

The results presented in Table 1 indicated that for both periods, that is, the pre and post-MACE, Chitipa price series was $I(0)$, i.e., stationary in levels while the rest of the markets were $I(1)$ (i.e., non-stationary). This implies that Chitipa market did not share common trend with dominant central markets such as Lilongwe and Mzuzu in both periods. Therefore it was excluded from co-integration and causality analyses since its inclusion would increase the number of co-integrating vectors.

Table 1: Results of the test of stationarity using ADF test for unit roots

Market	LEVELS			FIRST DIFFERENCE				CRITICAL VALUES	
	Coefficient	t-statistic	No. of Lags	Coefficient	t-statistic	No. of Lags	Integration Order	1%	5%
PRE-MACE PERIOD (1994:01 - 2004:08)									
Chitipa	-0.033	-3.847	2	-	-	-	I(0)	-4.031	-3.447
Karonga	-0.042	-2.063	1	-0.912	-6.620	9	I(1)	-4.034	-3.448
Mzuzu	-0.028	-3.159	10	-0.883	-5.436	9	I(1)	-4.034	-3.448
Salima	-0.037	-3.332	9	-1.301	-5.854	12	I(1)	-4.035	-3.448
Lilongwe	-0.028	-2.012	2	-1.197	-9.064	1	I(1)	-4.033	-3.447
Chimbiya	-0.035	-3.319	3	-1.355	-8.085	2	I(1)	-4.034	-3.448
Ntaja	-0.033	-3.146	1	-1.123	-8.127	1	I(1)	-4.033	-3.447
Lunzu	-0.036	-2.193	2	-1.246	-9.406	1	I(1)	-4.032	-3.447
Bangula	-0.033	-3.274	1	-1.103	-12.404	0	I(1)	-4.031	-3.447
POST-MACE PERIOD (2004:09 - 2007:12)									
Chitipa	-0.115	-3.921	3	-	-	-	I(0)	-4.260	-3.556
Karonga	-0.208	-3.011	0	-0.993	-5.952	0	I(1)	-4.279	-3.556
Mzuzu	-0.360	-2.749	2	-1.123	-6.657	0	I(1)	-4.260	-3.548
Salima	-0.226	0.797	1	-0.649	-5.472	11	I(1)	-4.362	-3.592
Lilongwe	-0.122	-1.821	1	-0.904	-5.370	0	I(1)	-4.260	-3.548
Chimbiya	-0.209	-2.286	2	-0.835	-4.439	2	I(1)	-4.279	-3.556
Ntaja	-0.182	-2.401	2	-0.820	-4.861	0	I(1)	-4.260	-3.548
Lunzu	-0.163	-2.051	4	-0.734	-4.759	2	I(1)	-4.279	-3.556
Bangula	-0.188	-2.039	6	-0.854	-4.965	0	I(1)	-4.260	-3.548

Notes: All variables are in natural logarithm. The ADF tests $H_0: \Pi \sim I(1)$ against $H_A: \Pi \sim I(0)$.

4.2 Determining the Extent of Spatial Market integration

Following Rashid (2004), tests on the extent of rice market integration were done through a sequential search for $n-1$ co-integrating vectors. The Johansen's λ_{Trace} tests for the sequential search are shown in Table 2. For each set of markets, the null hypothesis of $r = (n - 1)$ was tested against the alternative that $r = (n - 2)$, where r is the number of co-integrating vectors and n is the number of markets. The results show that the alternative hypothesis of $r = (n - 2)$ co-integrating vectors is rejected for Lilongwe-Mzuzu link in the pre-MACE period at 5% level of significance. However, when Lunzu is added to the Lilongwe-Mzuzu link, the study fails to reject the hypothesis of $r = (n - 2)$ co-integrating vectors at 5% level in the same period. The same holds when Lunzu and Bangula are added to the other six markets at 5% level of significance in the Pre-MACE period. Therefore, rice prices in these two markets and in Chitipa (which tested stationary in levels), did not share the common trend with other six major markets in Malawi during the 1994-2004 period. This observation could be attributed to the fact that Lunzu and Bangula are distant markets from other markets under this study. In addition, Bangula market which is situated in Nsanje district of southern Malawi has poor road infrastructure which is likely to impede trade with other markets.

Table 2: Johansen's sequential search trace tests for co-integrating vectors $\{H_0: r = (n - 1) \text{ against } H_A: r < (n - 1)\}$

Markets	r	Trace Statistics	Critical Values
PRE-MACE PERIOD (1994:01 - 2004:08)			
Lilongwe + Mzuzu	0	18.110	15.41
	1	3.218	3.76
Lilongwe + Mzuzu + Lunzu	1	10.285	15.41
	2	2.293	3.76
Lilongwe + Mzuzu + Karonga	1	23.168	15.41
	2	3.327	3.76
Lilongwe + Mzuzu + Karonga + Ntaja	2	23.490	15.41
	3	3.593	3.76
Lilongwe + Mzuzu + Karonga + Ntaja + Chimbiya	3	20.036	15.41
	4	3.372	3.76
Lilongwe + Mzuzu + Karonga + Ntaja + Chimbiya + Salima	4	20.215	15.41
	5	3.403	3.76
Lilongwe + Mzuzu + Lunzu + Karonga + Ntaja + Chimbiya + Salima + Bangula	6	15.216	15.41
POST-MACE PERIOD (2004:09 - 2007:12)			
Lilongwe + Mzuzu	0	16.809	15.41
	1	3.131	3.76
Lilongwe + Mzuzu + Lunzu	1	21.474	15.41
	2	3.217	3.76
Lilongwe + Mzuzu + Lunzu + Karonga	2	23.642	15.41
	3	4.681	3.76
Lilongwe + Mzuzu + Lunzu + Karonga + Ntaja	3	23.389	15.41
	4	4.530	3.76
Lilongwe + Mzuzu + Lunzu + Karonga + Ntaja + Chimbiya	4	19.060	15.41
	5	3.863	3.76
Lilongwe + Mzuzu + Lunzu + Karonga + Ntaja + Chimbiya + Salima	5	19.605	15.41
	6	0.498	3.76
Lilongwe + Mzuzu + Lunzu + Karonga + Ntaja + Chimbiya + Salima + Bangula	6	15.740	15.41
	7	3.416	3.76

Notes: The critical values for $H_A: r < (n - 1)$ are 20.04 and 15.54 at 1% and 5%, respectively.

The results for the post-MACE period suggest that there was an improvement in the extent of spatial rice market integration in Malawi between 2004 and 2007. All markets including Lunzu and Bangula shared a common trend during this period. The significance of Lunzu and Bangula sharing longrun interrelationship with other markets during the period after the commencement of an ICT project indicates that ICT intervention has had an effect in linking distant markets through trade. It implies that there exists causality between them in at least one direction (Gujarati, 1995).

4.3 Determining Causality Relationships

Co-integration per se cannot be used to make inferences about the direction of causation between the prices. Therefore we conducted the Granger causality tests. These tests were carried out following regression equation (5As in the ADF tests, the specification of lag length in the equation is critical. We therefore used the Akaike Information Criterion (AIC) to determine the appropriate lag length to include in the regression equations. The causality tests focused on the significance of β_1 and β_2 as specified in equation (5). The results of the Granger causality test are presented in Table 3 They cover only the causality results between the major urban markets (Mzuzu, Lilongwe and Lunzu) and the peripheral markets.

As shown, pre-MACE period results indicate that the null hypothesis of uni-directional causality for 11 out of 18 market links cannot be rejected. Uni-directional causality implies that either α_2 is statistically different from zero ($\alpha_2 \neq 0$) and α_1 is not statistically different from zero ($\alpha_1 = 0$), or vice-versa. For example, in the Lilongwe-Mzuzu link, the hypothesis that α_2 is not statistically different from zero ($\alpha_2 = 0$) cannot be rejected at 5% level of significance. This indicates that the causality is unidirectional, with prices in Mzuzu market Granger causing the prices in Lilongwe market. For Post-MACE period, unidirectional causality is found in 9 out of the 18 links.

Bi-directional causalities were found to exist in 4 out of the 18 market links during the pre-MACE period. For example, Mzuzu-Karonga and Lunzu-Ntaja were among the markets which indicated interdependence between them. In other words, price in one rice market reacted to any deviations of price in the other rice market from its equilibrium path. This bi-directional causality was however more pronounced in the post-MACE period where causal feedbacks were found to exist in 7 out of the 18 market links. These findings indicate increased interdependence of regional markets during the post-MACE period as compared to the period before MACE. Indeed, a test of the difference in means between the two periods was significant at 5%. Independent causality where both P_{it} and P_{jt} do not cause each other was found in three and two market links during the pre-MACE and post-MACE price series, respectively.

Table 3: Pair-wise Granger Causality Tests by Regional Centres

Market <i>i</i>	Market <i>j</i>	β_i	p-value	β_j	p-value	Direction of Causality
PRE-MACE PERIOD (1994:01-2004:08)						
Lilongwe	Mzuzu	-0.143	0.001	0.057	0.198	Unidirectional
	Lunzu	-0.079	0.094	0.059	0.121	Unidirectional
	Chimbiya	-0.122	0.004	0.123	0.035	Bidirectional
	Ntaja	-0.133	0.007	0.189	0.210	Unidirectional
	Salima	-0.096	-0.296	0.100	0.001	Unidirectional
	Karonga	-0.096	-0.096	0.194	0.000	Bidirectional
	Bangula	-0.096	-0.196	0.085	0.181	Independent
Mzuzu	Karonga	-0.234	0.000	0.282	0.002	Bidirectional
	Chimbiya	-0.297	0.000	0.268	0.352	Unidirectional
	Ntaja	-0.204	0.004	0.287	0.000	Unidirectional
	Lunzu	-0.099	0.351	0.143	0.001	Unidirectional
	Salima	-0.166	0.164	0.234	0.000	Unidirectional
	Bangula	-0.064	0.292	0.117	0.010	Unidirectional
Lunzu	Karonga	-0.163	0.000	0.185	0.320	Unidirectional
	Chimbiya	-0.143	0.120	0.082	0.328	Independent
	Ntaja	-0.246	0.000	0.136	0.037	Bidirectional
	Salima	-0.164	0.010	0.187	0.065	Unidirectional
	Bangula	-0.073	0.282	0.111	0.106	Independent
POST-MACE PERIOD (2004:09-2007:12)						
Lilongwe	Mzuzu	-0.056	0.091	0.304	0.001	Bidirectional
	Lunzu	-0.183	0.214	10.081	0.235	Independent
	Chimbiya	-0.146	0.012	0.251	0.075	Bidirectional
	Ntaja	-0.123	0.003	0.029	0.712	Unidirectional
	Salima	-0.053	0.029	0.206	0.003	Bidirectional
	Karonga	-0.231	0.007	0.214	0.327	Unidirectional
	Bangula	-0.389	0.000	0.047	0.732	Unidirectional
Mzuzu	Karonga	-0.481	0.000	0.092	0.047	Bidirectional
	Chimbiya	-0.269	0.013	0.272	0.000	Unidirectional
	Ntaja	-0.305	0.014	0.211	0.005	Bidirectional
	Lunzu	-0.299	0.110	0.185	0.003	Unidirectional
	Salima	-0.508	0.001	0.040	0.667	Unidirectional
	Bangula	-0.260	0.490	0.201	0.002	Unidirectional
Lunzu	Karonga	-0.020	0.803	0.339	0.004	Unidirectional
	Chimbiya	-0.091	0.126	0.431	0.230	Independent
	Ntaja	-0.196	0.016	0.379	0.018	Bidirectional
	Salima	-0.018	0.034	0.019	0.014	Unidirectional
	Bangula	-0.012	0.045	0.098	0.034	Bidirectional

4.4 Dynamic Interrelationships among Prices at Different Markets

We also computed adjustments between Lilongwe and other peripheral markets. Lilongwe was selected because it is one of the major urban centres in the country and is situated in the centre where its impact is expected to be transmitted to all the three regions of Malawi. Two lags for the markets were used in the shortrun regression as determined by the Akaike Information Criterion. Following Chirwa (2001), the study included quarterly seasonal dummies to capture the effect of seasonality. The first quarter (Q1) coincided with the rice crop growing period, the second quarter (Q2) with the harvesting season, the third quarter (Q3) is the marketing and slack season, and the fourth quarter (Q4) is the farm preparation season.

The parameters of interest were the coefficient of the contemporaneous change (δ) in Lilongwe market and the coefficient of the lagged error correction term (θ). The error correction term (ECT) was derived from the residual of the co-integration vector of the dependent and independent market in the bivariate analysis. The results are shown in Table 4. They suggest that both causality and co-integration have increased over time, further confirming the hypotheses of greater co-integration and market integration during the period MACE was in existence.

Table 4: Shortrun and adjustment speed coefficients

Market j^*	PRE-MACE (1994:01-2004:08)		POST-MACE (2004:09-2007:12)	
	δ	θ	δ	θ
Karonga	0.226 (0.096)	-0.298 (0.027)	0.094 (0.023)	-0.452 (0.001)
Mzuzu	0.179 (0.057)	-0.321 (0.012)	0.153 (0.012)	-0.462 (0.012)
Salima	0.211 (0.025)	-0.322 (0.014)	0.358 (0.003)	-0.374 (0.004)
Chimbiya	0.257 (0.036)	-0.282 (0.004)	0.242 (0.008)	-0.386 (0.006)
Ntaja	0.141 (0.062)	-0.252 (0.003)	0.164 (0.090)	-0.452 (0.076)
Lunzu	0.126 (0.078)	-0.299 (0.021)	0.224 (0.078)	-0.419 (0.090)
Bangula	0.103 (0.978)	-0.263 (0.023)	0.396 (0.000)	-0.421 (0.003)
Average	0.177	-0.291	0.233	-0.424

* Lilongwe market is an independent market. Figures in parenthesis are critical p-values

The results specifically show that the contemporaneous (short-run) changes in the Lilongwe's rice prices significantly affected the price change in the other markets with the coefficients ranging between 0.126 and 0.257. The only exception is Bangula rice market during the Pre-MACE period. The overall average change was 17.7%. Overall, the impact of shortrun changes in rice prices in Lilongwe on changes in other markets was more pronounced during the post-MACE period with the coefficients ranging between 0.094 and 0.396. On average, shortrun changes in rice prices in Lilongwe explained around 23% of changes in the other markets. The difference between pre and post-MACE is significant (at 5% level of significance) that that MACE the presence of MACE is affecting the efficiency of rice markets.

The results also showed that the speed of adjustment during the pre-MACE period was slowest in Ntaja (-0.252) and fastest in Salima (-0.322). On average, 29.1% of the price adjustments to the long-run equilibrium were taking place within a month. During the post-MACE period the slowest speed of adjustment was in Salima (-0.374) and fastest speed was in Mzuzu (-0.462). On average, 42.2% of the price adjustments to the long-run equilibrium taking place within a month in post-MACE period. The difference in the speed of adjustment to the long-run equilibrium between the pre-MACE and Post-MACE periods is statistically significant at the 1% level.

5.0 CONCLUSIONS

This study set to examine whether MACE's MIS has improved the efficiency with which prices in different rice markets in Malawi are transmitted. In particular it tested the extent to which the markets are co-integrated. The study finds that the MACE (an ICT-based MIS) has indeed improved the spatial integration of rice markets in Malawi. This finding corroborates those of Mabota *et al* (2003). This study concludes that ICT-based interventions can enhance integration of spatially located distant markets. This is probably because provision of market information enables smallholder rice farmers to access better markets and better prices for their produce. It also empowers them to access better-paying market and/or take advantage of opportunities that exist in distant rice markets. The effect of MACE performance of rice markets in Malawi is likely to be due to the improved availability of the market (i.e., price and quantity) information to buyers and sellers.

An important policy lesson to be learnt from the MACE experiment is that the development of a well functioning and effective ICT-based intervention through the market information system indirectly contributes to the improvement in the performance of markets. This then translates to improved market efficiency of agricultural market and could contribute to food security through enhanced trade. The implication of these findings is that the government individually or jointly with the private sector needs to invest in the provision of market information. Some aspects of agricultural information have public good attributes and hence cannot be left to the private sector. Under such cases, the government needs to step in to provide the market information.

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