ANALYSIS OF MAIZE MARKET INTEGRATION IN MALAWI: ARE GOVERNMENT INFLUENCED ADMARC PRICES TRANSMITTED TO RETAIL MARKETS?

Beston B. Maonga[1*], Wisdom Richard Mgomezulu[1]

[1] *Lilongwe University of Agriculture and Natural Resources, faculty of Development Studies, Department of Agricultural and Applied Economics, Bunda Campus, P.O. Box 219, Lilongwe, Malawi*
**Corresponding author's email: maonga.b05@gmail.com.*

Abstract

Maize is economically an important food commodity whose pricing defines household food security in Malawi. The study focuses on six strategic retail maize markets spread across the northern (Mzimba, Chitipa), central (Dowa, Lilongwe) and southern (Ntaja, Lunzu) regions. The Malawi Government's agriculture datasets collected by the Agricultural Market Information System are used for the analysis. The trend of maize prices for the period 2005-2017 is studied using economic analytical methods. Vector Error Correction model and Granger causality tests are applied to determine market integration and price transmission between ADMARC and the retail maize markets. Stationarity test is conducted using Augmented Dickey Fuller test. Using the Johansen test, co-integration model is applied to determine correlation between ADMARC and retail market prices. The findings show that contrary to the mandate of serving as an instrument for transmitting maize prices to other markets across the country, ADMARC fails to transmit price information to retail markets in Malawi except Dowa market. The long-run coefficients also show no significant relationship between ADMARC prices and those in the retail markets. However, strong integration exists among the retail markets both in the short-run and long-run. The study demonstrates that ADMARC does not perform price leading function in the pricing of maize to guarantee food security among low income households in Malawi. As a social protection agency, ADMARC should purchase maize at a floor price that is competitive with retail market prices. Increased investment, and reduced administrative and bureaucratic constraints in the procurement of maize would be required. ***Keywords**:* Maize price, maize market, co-integration analysis, price transmission, Malawi.

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1. Introduction

Maize remains Malawi's staple food commodity, accounting for almost 70 percent of farming land and nearly 90 percent of cereal land in the country (Smale & Jayne, 2012). It is a key crop of economic importance that defines food security among households in Malawi. Malawi is one of the largest consumers of maize in the world with annual per capita maize consumption of 148 kg (Taylor, 1986). Therefore, relationships and developments in maize marketing have critical economic policy implications for the country.

The market structure of maize in Malawi lies between a perfect competition and a monopolistic competition and it varies periodically. On one hand, perfect competition is exhibited by the presence of a very large number of sellers (farmers) and buyers of maize in the market, where every seller considers selling any amount of maize at the going market price; and there is no rivalry among individual firms involved in maize selling (Koutsoyiannis, 1985). This is common soon after maize harvesting (between April and May), a period characterized by increased maize supply in the markets. During this time, demand for maize equally increases by a combination of maize traders (vendors and middlemen) and direct consumers who buy large quantities of the commodity and store for home use and re-sale during the lean season, respectively. In the lean season, which mainly covers between October and February, the situation changes as the market structure takes a variant of monopolistic competition. Although with undifferentiated product (maize), the market has a very large number of sellers who decide prices differently. Sometimes sellers raise prices while mindful of keeping some of their customers; at other times they slightly increase their sales by lowering the price (Koutsoyiannis, 1985).

The Government of Malawi intervenes in the marketing of maize to ensure food security in the country. Through the National Food Reserve Agency (NFRA), the Government of Malawi employs measures to ensure that consumers and producers of maize are highly protected from market outcomes that result into both household food insecurity and low profits or losses by the producers. NFRA works through the Agricultural Development and Marketing Corporation (ADMARC). ADMARC was established in 1971, about seven years after Malawi got independence from Great Britain, as a Government owned corporation (parastatal) to promote the agro-based Malawian economy by increasing agricultural production and farm commodity exports and to serve smallholder farmers through a monopoly market structure involved in the purchase and sale of agricultural commodities. However, the implementation of Structural Adjustment Programs (SAPs) in the early 1990s subjected ADMARC to a huge competition from the private traders in retail agro-markets. In 2003 ADMARC changed from a parastatal to a Limited Liability Company but with maintained Government control over it. Amidst heavy competition, nevertheless, ADMARC remains with the mandate of protecting both producers and consumers by offering "good market prices" for maize.

Through ADMARC, minimum farm gate prices are set for maize; these prices are expected to be transmitted to other markets to safeguard the welfare of both consumers and producers. In times of surplus, the NFRA buys the excess maize from the market and stores it in its silos which are strategically located to serve the population in the country. The grain is released back to the market during periods of deficits. In this manner, NFRA is meant to play an important role in the stabilization of maize market prices in Malawi. Nevertheless, due to bureaucratic red tapes in the procurement processes and financial hiccups, ADMARC joins the market to purchase the maize from

farmers 2 to 3 months later after commencement of sales between April and May. By the time ADMARC opens around July or August, vendors and other traders have already purchased huge volumes of the grain at low prices from the cash-strapped smallholder farmers. Therefore, ADMARC's "good" farm-gate price that is intended to serve producers never materializes as most smallholder farmers would have sold out their maize to vendors and other traders. During the lean season, which mostly covers 4 to 5 months of low food supplies in Malawi, ADMARC comes out with relatively low selling price for maize in order to protect the consumers. However, because ADMARC stocks low volume of maize, its selling price is never sustained over the lean season, thus leaving vendors and other maize traders to control marketing of the commodity with high prices for increased profits.

The efficiency of the NFRA in price stabilization depends on its ability to transmit the set ADMARC prices to other retail maize markets in the country. It is however, not understood whether ADMARC integrates with other retail maize markets; the influence of ADMARC in transmitting price information to the other retail maize markets also remains unknown. These gaps pose challenges in the maize pricing policy debate in Malawi. The objective of this study therefore, is to determine the nature of market integration and price transmission between ADMARC and the other retail maize markets in Malawi. Through this paper, the study seeks to refine the policy direction with evidence based options in the management of government monitored maize pricing in Malawi.

2. Methodology

2.1 Data Source

The study used the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (AMIS) collected from 2005 to 2017. AMIS collects and disseminates data on agricultural commodity prices from over 80 markets in Malawi. An average of the prices from all the 80 markets is computed on a monthly basis. This study used the monthly prices data covering the stated period with 156 observations from six strategic retail maize markets. The selected markets included Mzimba, and Chitipa from the northern region; Dowa and Lilongwe representing central region; and Ntaja and Lunzu in the southern region. ADMARC price data between 2005 and 2008 were collected from government reports and publications while data from 2009 onwards were collected from the Ministry of Agriculture. Using 2010 as base year, the monthly maize prices were converted to real terms (Granger & Terasvirta, 1999). The maize prices are recorded in Malawi Kwacha per kilogram (MWK/kg); - US$1 is equivalent to MWK750.

2.2 Price movements in maize over time in Malawi

Figure 1 presents price movements over time between 2005 and 2017 across the selected markets in Malawi. There has been a general increase in maize price over time, which is mainly due to a continued rise in demand for commodity in Malawi. Specific notable increases in price series are observed around 2007/2008, 2012/2013 and 2016/2017 farming seasons mainly because production of low relative to demand in those periods due to low rainfall. In addition, ADMARC prices mostly seem to be below the retail prices except for the period 2010-2012. The high ADMARC prices than retail market prices in the 2010-2012 period imply a high maize production and supply relative to market demand. With low prices on retail markets maize producing farmers and traders would not find trading in maize a profitable venture. Therefore, as an instrument of NFRA, ADMARC stepped in with higher prices in order to protect both the maize producers and the consumers of the food commodity. Through higher

ADMARC prices, on one hand, maize producers and traders were given an incentive to stay on as their sales revenues would not have been squeezed by the surplus maize supply on the market. On the other hand, ensuring a steady supply of maize on the markets served consumers of the commodity.

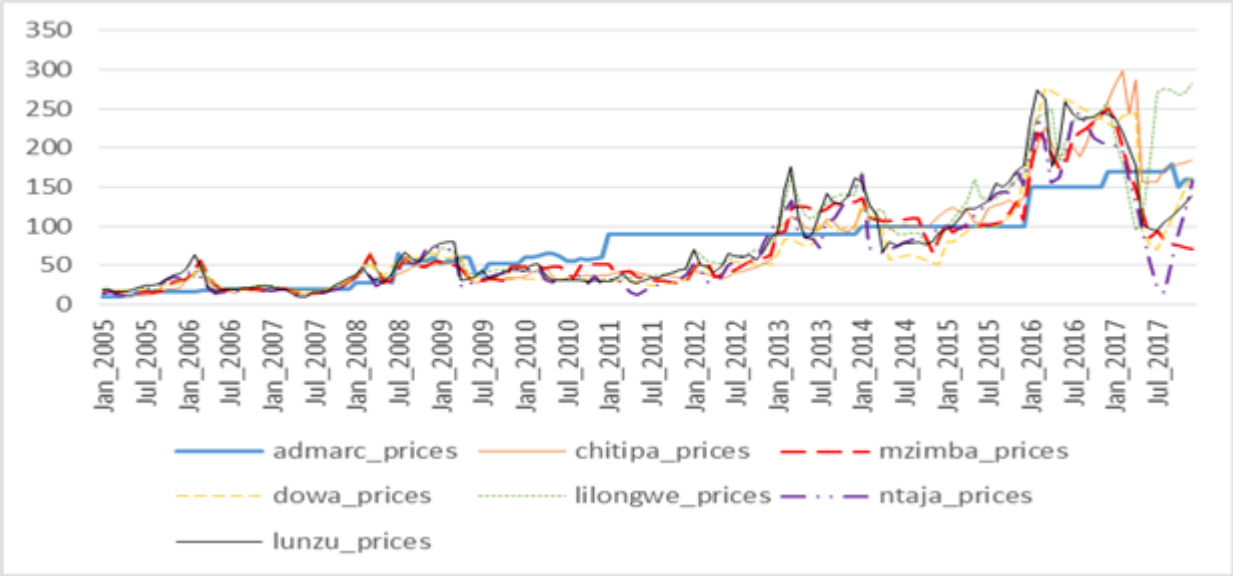

Fig.1. *Maize price movement over time period 2005-2017, Malawi, (Malawi Kwacha)*

Source: Own graphic according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

2.3 Empirical Framework

The study employed the Vector Error Correction (VEC) model and Granger causality to test for causality between ADMARC prices and other market prices. To avoid misspecification bias, the study tested for stationarity of the price series using Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests (equation 1). The ADF and PP tests were used to test for presence of a unit root in the price series under the null hypothesis that the series were non-stationary (presence of a unit root) against an alternative that they were stationary. This was a pre-requisite for testing for co-integration as there was a possibility of a long-run relationship among the maize price series across the selected markets. This study used the ADF for its simplicity and ease of interpretation.

$$\Delta P_t = c + \beta_t + \delta P_{t-1} + \sum_{j=1}^{k} \alpha_i \Delta P_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where ΔP_t is the difference in maize prices between ADMARC and other retail maize markets at time trend t; ΔP_{t-i} expresses the first differences of price series with k lags, is the white noise residual estimated at zero mean and constant variance. The coefficients (c, β, δ, α) are parameters to be estimated. The null hypothesis is that the series are non-stationary and are tested by observing the presence of a unit root. If the coefficient for δ is not statistically different from zero, then the series are non-stationary.

After testing for stationarity, existence of a long-run relationship was tested through the Johansen cointegration test, which explains the long-run relationship among non-stationary series. Stemming from the theory and concepts of rank matrix, the Johansen co-integration test is based on maximum likelihood estimation and two statistics

namely: maximum eigenvalues and a trace-statistics. With the ability to test for long run relationships in more than two series, the Johansen co-integration test is highly reliable and a powerful tool (Johansen & Juselius, 1990; Lutkepohl, Saikkonen, & Trenkler, 2001). The trace statistic tests the null hypothesis that the number of co-integrating vectors is less than or equal to q against a general unrestricted alternative q = r as specified in equations (2) and (3).

$$\lambda_{trace(r)}=-T\sum_{i=1} i=r+1 \ln(1-\lambda_t) \ldots\ldots\ldots\ldots\ldots (2)$$

$$\lambda_{max(r,r+1)}=-T ln(1-\lambda_{r+1}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, T is the number of usable observations, and the λ_r are the estimated eigenvalues from the T matrix; r is the rank which indicates the number of co-integrating relationships.

Realizing that co-integration only tests for the presence of a relationship and not causality, a Granger causality test was used to estimate causality between ADMARC prices and market retail price series. The Granger causality test was mainly used in a Vector Auto-regressive (VAR) system, mindful of the fact that there exists a possibility of observing the short-term causal relationship when series are co-integrated (Masih and Masih, 1996). This can be specified as in equations (4) and (5).

$$Y_t = \alpha_{1o} + \alpha_{11}Y_{t\text{-}1} + \alpha_{12}X_{t\text{-}1} + \varepsilon_{t1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$X_t = \alpha_{2o} + \alpha_{21}X_{t\text{-}1} + \alpha_{22}Y_{t\text{-}1} + \varepsilon_{t2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Equations (4) and (5) explain a bivariate relationship between the two series (X and Y) which in our case are ADMARC prices and retail market prices, respectively. Two null hypotheses can be tested from the two equations. The first one is that X does not granger cause Y and the second is that Y does not granger cause X. Thus, we can have a unidirectional causation if either hypothesis is rejected; a bidirectional causation if both null hypotheses are rejected; and no causality if neither hypotheses are rejected.

Before testing for co-integration in the maize price series, optimal lag length was estimated as required by the Johansen co-integration test specification. Determining the optimal number of lags to be included is essential in testing the order of integrity of the data series (Genchev et al., 2017). The study used Akaike's Information Criterion (AIC) rule in the selection of the number of lags in the price series as specified by Akaike (1973), in equation (6).

$$AIC = -2\ln(L) + 2 * k(32.18) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where the likelihood value is given by L, and number of estimated parameters is given by k. It is noted that the estimated model ought to take the number of lags with the smallest AIC.

2.4 Market Integration: ADMARC Minimum Prices and Retail Prices Transmission

The study followed a two-step process in selecting a market integration model. The first step was testing for stationarity of the maize price series. According to (Kharin, 2015) if data series are stationary, we go further to run a Vector Autoregressive (VAR)

model at levels (I(0)) and perform a Granger causality test to test if the ADMARC prices granger cause the retail prices. If the maize price series are non-stationary I(1) processes, we move to the next step which is to test for co-integration. Sendhil et al. (2014) observed that short-run market integration can be noted through correlation analysis using correlation coefficients matrix. If there exists a co-integrating relationship, then we run a Vector Error Correction (VEC) model and estimate short and long-run relationships between the two series. If there is none then we estimate a VAR of integrated prices and then test for Granger causality between the integrated price series.

Lastly, to test for short and long-run relationships when there exists a co-integrating relationship, the VEC model was in this case used instead of the VAR (Kharin, 2015). The VEC is a restricted VAR since it contains an error correction coefficient which adjusts the series towards its long-term equilibrium. For the ADMARC set prices and retail prices, we present the VEC model of spatial market integration as shown in equations (7) and (8).

$$\Delta y_t = \beta_{y0} + \beta_{y1}\Delta y_{t-1} + ... + \beta_{yp}\Delta y_{t-p} + \gamma_{y1}\Delta x_{t-1} + ... + \gamma_{yp}\Delta x_{t-p} - \lambda_y(y_{t-1} - \alpha_0 - \alpha_1 x_{t-1}) + z_t^y \quad .....7$$

$$\Delta x_t = \beta_{x0} + \beta_{x1}\Delta y_{t-1} + ... + \beta_{xp}\Delta y_{t-p} + \gamma_{x1}\Delta x_{t-1} + ... + \gamma_{xp}\Delta x_{t-p} - \lambda_x(y_{t-1} - \alpha_0 - \alpha_1 x_{t-1}) + z_t^x \quad .....8$$

Where $y = \alpha_0 - \alpha_1 x_t$ depicts existence of long-run co-integrating relationships between ADMARC and retail prices. The error correction parameters represented by λ_y and λ_x give the speed of adjustment of the series. A negative and significant speed of adjustment implies that any fluctuations between the price series will result into a stable long-run relationship or equilibrium. The VEC model was demarcated into short-run and long-run relationships among the markets (Suharno, 2018). It should be noted that co-integration shows presence of a relationship but lacks causality and direction of the price information flow. Indeed, it would be wise for policy purposes to understand if the government instrument (ADMARC) is able to transmit information to retail maize markets in the short-run. Pursuing this, the null hypothesis that ADMARC prices do not granger cause retail markets was tested using the test command ("vargranger") after a VEC (Sendhil et al., 2014). Lastly, in order to be sure if we really have to trust the estimated results the VEC model was tested for stability using the VEC stable test. The VEC model is considered stable and reliable if no root sits outside the unit modulus.

3. Results and Discussion

3.1 Stationarity test results for 1st differences

The results of both the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests show that ADMARC and retail maize price series are all significantly stationary ($p<0.01$) after the first difference (Table 1), implying that maize prices are all integrated of order one.

Tab. 1. *Stationarity Test Results*

Augmented Dickey Fuller (ADF) results			Phillips Perron (PP) results	
Natural log of Maize Prices	Level (I(0))	First Difference (I(1))	Level (I(0))	First Difference (I(1))
ADMARC Prices	-1.691	-13.878***	0.998	-13.767 ***
Chitipa	-1.281	-11.250***	0.370	-11.197***
Mzimba	-1.603	-10.911***	-0.077	-10.911***
Dowa	-1.282	-11.324***	0.3	-11.296***
Lilongwe	-0.392	-9.749***	0.971	-9.567***
Ntaja	-1.605	-9.189***	-0.542	-9.150***
Lunzu	-1.488	-9.508***	0.072	-9.283***

***Significant at 1 percent

Source: Authors' calculation according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

3.2 Correlation of maize prices among markets in Malawi

Correlation results in Table 2 show that ADMARC prices are strongly and positively correlated with retail market prices. This shows evidence of short-run integration among the maize markets in Malawi together with the ADMARC (government set) prices. Thus, there exists a possibility of price information flow among the maize markets in the short run.

Tab. 2. *Maize Price Correlation*

Correlation	ADMARC	Chitipa	Mzimba	Dowa	Lilongwe	Ntaja	Lunzu
ADMARC	1.0000						
Chitipa	0.9001	1.0000					
Mzimba	0.8838	0.9796	1.0000				
Dowa	0.8308	0.9617	0.9635	1.0000			
Lilongwe	0.8807	0.9685	0.9687	0.9649	1.0000		
Ntaja	0.8244	0.9332	0.9477	0.9510	0.9454	1.0000	
Lunzu	0.8559	0.9596	0.9603	0.9699	0.9749	0.9764	1.0000

Source: Authors' calculation according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

3.3 Results of optimal lag test

After running the Akaike's Information Criterion (AIC), the study selected an optimal lag length of 2 (with smallest AIC) for the market price series in Malawi (Table 3). Based on the results, a co-integration test of lag length 2 was run to test for the presence of any long-run relationship leading to a VEC model; the trace statistics and maximum eigenvalues test were used. The null hypothesis at rank zero was that there exists no co-integrating relationship among the maize price series against an alternative that there exist one or more co-integrating relationships.

Tab. 3. *Selection of Optimal Lag Length*

Lags	AIC	P-Value
0	1.48523	
1	-7.13978	0.000
2	-7.18404*	0.000
3	-7.06728	0.003
4	-6.75838	0.337

*Optimal lag length with smallest AIC

Source: Authors' calculation according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

Using both trace and max statistics, the study rejected the null hypothesis of no co-integration at 5 percent level of statistical significance, implying that there exists a long-run relationship among the maize price series in Malawi (See Table 4).

In checking for the rank of the co-integration, we find three co-integrating relationships among the series (Table 4); we fail to reject the null hypothesis at rank 3. The results show that data series are I(1) processes and integrated and that the maize market prices exhibit a long-run relationship; thus, supporting the necessity to run the VEC model in line with (Gujarati, 2013). The results further point that there indeed exists information flow (price transmission) among the maize markets in Malawi.

Tab. 4. *Co-integration Test of Long-Run Relationship among the Maize Price Series in Malawi*

Rank	Trace Statistics	5% Critical value	Max Statistics	5% Critical value
0	164.4	124.24	54.43	45.28
1	109.98	94.15	33.57	39.37
2	76.41	68.52	31.39	33.46
3	45.01	47.21	21.85	27.07

Source: Authors' calculation according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

3.4 Maize Market Integration and Spatial Price Transmission

Table 5 shows the short-run (differenced) effect and speed of adjustment (ECT) to long-run equilibrium of maize prices from ADMARC to the other 6 retail markets. ADMARC price series were considered first. As controlled prices that do not exploit consumers nor producers, it is expected that such price information must flow to the retail markets hence, possible integration with the other market prices. The results however show that the error correction coefficient (speed of adjustment) is positive and not significant. Normally, we would expect that the speed of adjustment should be negative and significant showing that when there are price shocks in retail markets (Chitipa, Mzimba, Dowa, Lilongwe, Ntaja and Lunzu), ADMARC maize prices would revert or converge back to their long-run equilibrium. These results however, show that the ADMARC prices diverge from their equilibrium. A short-run relationship nevertheless, exists running from Dowa market, implying that a 1 percent increase in prices at Dowa market significantly increases ADMARC prices by 15.7 percent ($p<0.05$). This shows that in the short-run, ADMARC and Dowa prices are able to move in the same direction; and price information is able to flow from Dowa retail market to ADMARC in setting the maize prices.

Tab. 5. *Short-Run Integration among Maize Market Prices in Malawi*

Price Series	ADMARC	Chitipa	Mzimba	Dowa	Lilongwe	Ntaja	Lunzu
ECT	0.002	0.001	-0.0001	0.002	-0.004**	0.008**	0.013***
	(0.001)	(0 .002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
ADMARC	-0.22***	-0.03	0.026	-0.095	-0.07	0.238	0.172
	(0.08)	(0.107)	(0.113)	(0.111)	(0.11)	(0.17)	(0.14)
Chitipa	0.09	0.022	0.258**	0.056	0.067	-0.078	0.21
	(0.075)	(0.1)	(0.106)	(0.104)	(0.11)	(0.159)	(0.13)
Mzimba	-0.049	0.05	-0.13**	0.152*	0.006	0.058	-0.13
	(0.064)	(0.086)	(0.091)	(0.09)	(0.092)	(0.137)	(0.12)
Dowa	0.157**	-0.046	0.006	-0.11	-0.21**	0.147	-0.01
	(0.065)	(0.088)	(0.093)	(0.091)	(0.09)	(0.139)	(0.12)
Lilongwe	0.019	-0.016	0.137	-0.14	0.126	-0.54***	-0.32***
	(0.068)	(0.091)	(0.096)	(0.09)	(0.09)	(0.14)	(0.12)
Ntaja	-0.08	0.18**	0.135*	0.156**	-0.024	0.192	0.24**
	(0.056)	(0.074)	(0.07)	(0 .08)	(0.08)	(0.12)	(0.1)
Lunzu	0.038	0.304***	0.23**	0.381***	0.29***	0.37**	0.33***
	(0.07)	(0.093)	(0.09)	(0.097)	(0.1)	(0.14)	(0.12)

Standard Errors in parentheses; ***Significant at 1%, ** Significant at 5%, *Significant at 10%

Source: Authors' calculation according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

The second price series was that for Chitipa Market. The speed of adjustment in this scenario was also positive and not significant. However, there exists evidence of a short-run relationship running from Ntaja to Chitipa and Lunzu to Chitipa. Thus, a 1 percent increase in prices at Ntaja increases maize prices at Chitipa market by 18 percent ($p<0.05$). Again, 1 percent increase in prices at Lunzu market increases prices at Chitipa by 30.4 percent ($p<0.01$). Thus, maize price information is able to flow from Ntaja and Lunzu markets to Chitipa market.

For Mzimba, the speed of adjustment was also not significant despite showing possibilities of convergence to long-run equilibrium (negative ECT). However positive and significant short-run relationships run from Chitipa to Mzimba ($p<0.05$), Ntaja to Mzimba ($p<0.1$) and Lunzu to Mzimba ($p<0.05$). Thus, price information flows from Chitipa, Ntaja and Lunzu to Mzimba, respectively. Likewise, Dowa shows positive short-run relationships running from Mzimba ($p<0.1$), Ntaja ($p<0.05$) and Lunzu ($p<0.01$). Price information flows from Mzimba, whereby a 1 percent increase in price at Mzimba market causes a price increase at Dowa market by 15.2 percent. Similarly, 1 percent increase in maize price at Ntaja causes a 15.6 percent price rise at Dowa while a percentage rise in maize price at Lunzu causes a price increase at Dowa market by 38.1 percent.

Lilongwe was the only market with a negative and significant ECT ($p<0.05$), implying that when faced with a price shock the system reverts back to equilibrium at speed of 0.4 percent a month. Between markets, price information is able to flow from Dowa and Lunzu markets to Lilongwe market. There is a negative short-run relationship between Lilongwe and Dowa in which a 1 percent increase in maize prices at Dowa market causes a 21 percent price reduction at Lilongwe market ($p<0.05$). On the contrary, there is a positive short-run relationship between Lunzu and Lilongwe markets; a percentage increases in maize price at Lunzu market causes a 29 percent price increase at Lilongwe market ($p<0.01$).

With regards to Ntaja market, the ECT was significant but positive showing divergence from equilibrium. However, there exist short-run relationships which run from Lilongwe ($p<0.01$) and Lunzu ($p<0.05$). Again, Lunzu has a significant and positive

ECT showing divergence from long-run equilibrium. Negative short-run relationships run from Lilongwe with an influence of 32 percent (p<0.01) price reduction on Lunzu prices, while a 1 percent price increase at Ntaja positively influences prices at Lunzu by 37 percent (p<0.05). Thus, information is able to flow from Lilongwe and Lunzu to Ntaja; and from Lilongwe and Ntaja to Lunzu. All in all, price shocks in Lunzu market are able to affect all markets except the ADMARC prices. Therefore, Lunzu market seems to be the market leader in the maize marketing in Malawi.

The presence of a co-integrating relationship among the maize price series implies the use of a VEC model and hence estimating the long-run co-integrating relationship vector among the maize price series. **Table 6** shows the long-run co-integrating vector for the maize prices running from the period 2005 to 2017. Since all price series are natural logs, results in **Table 6** are long-run elasticities. In the long-run, a 1 percent increase in Lilongwe prices is expected to increase ADMARC prices by 35.67 percent (p<0.01); a 1 percent increase in Ntaja prices is expected to increase ADMARC prices by 9.54 percent (p<0.1); while a 1 percent increase in Lunzu prices is expected to reduce ADMARC prices by 43.93 percent (p<0.01). This shows that in the long-run the government is able to consider price information on the retail markets in setting ADMARC prices.

Tab. 6. *Long-run co-integration analysis between ADMARC and retail maize prices, Malawi, 2005-2017*

Price Series	ADMARC	Chitipa	Mzimba	Dowa	Lilongwe	Ntaja	Lunzu
ADMARC	1	-0.159	1.19	0.223	0.028	0.104	-0.02
		(0.305)	(2.39)	(0.42)	(0.05)	(0.21)	(0.04)
Chitipa	-6.25	1	-7.48	-1.39	-0.175	-0.65	0.14
	(4.58)		(4.7)	(1.06)	(0.135)	(0.51)	(0.11)
Mzimba	0.84	-0.133	1	0.186	0.023	0.08	-0.02
	(5.19)	(0.678)		(1.15)	(0.142)	(0.52)	(0.12)
Dowa	4.47	-0.716	5.36	1	0.125	0.46	-0.1
	(4.23)	(0.696)	(5.27)		(0.122)	(0.46)	(0.09)
Lilongwe	35.67***	-5.7***	42.72***	7.96***	1	3.73***	-0.81***
	(5.74)	(0.93)	(6.8)	(1.28)		(0.61)	(0.12)
Ntaja	9.54*	-1.52*	11.44**	2.13*	0.26*	1	-0.22**
	(4.9)	(0.79)	(5.78)	(1.11)	(0.13)		(0.09)
Lunzu	-43.93***	7.03***	-52.6***	-9.81***	-1.23***	-4.6***	1
	(6.84)	(1.09)	(8.12)	(1.42)	(.17)	(0.58)	

Standard errors in parentheses, ***Significant at 1%, ** Significant at 5%, *Significant at 10%

Source: Authors' calculation according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

There exists no price information flow in the long-run from ADMARC to the retail maize markets, implying that restricted by its social responsibilities, ADMARC fails to compete with the vendors and private traders in the retail markets in Malawi. However, long-run relationships run among the retail markets showing the presence of long-run market integration among the retail markets. Lilongwe, Ntaja and Lunzu markets turned out to have significant long-run relationships with all the markets in the country, showing that price information from the 3 markets is transmitted to all the other markets including ADMARC. This implies that ADMARC receives price information from the retail markets instead of transmitting the prices to the retail markets, which is quite contrary to the NFRA mandate.

Granger causality test results **(Table 7)** show that ADMARC prices are only able to granger cause prices in Dowa maize market, indicating that generally, in the short-run, ADMARC fails to transmit price information to other retail markets in Malawi except

Dowa Market. This is again contrary to the mandate of the NFRA which uses ADMARC as an instrument for transmitting its set prices.

Tab. 7. *Results of Granger causality test for price transmission*

Null hypotheses	chi^2	P-value
ADMARC price does not granger cause Chitipa price	1.5	0.22
ADMARC price does not granger cause Mzimba price	0.57	0.4491
ADMARC price does not granger cause Dowa price	5.71	0.0169**
ADMARC price does not granger cause Lilongwe price	0.08	0.7742
ADMARC price does not granger cause Ntaja price	2.06	0.1507
ADMARC price does not granger cause Lunzu price	0.3	0.5827

Source: Authors' calculation according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

ADMARC's failure to granger cause prices in Malawi's major retail maize markets, has important implications on the accessibility of the food commodity by a majority of consumers in the country. For instance, considering that retail maize markets are dominated by private profit-oriented business entities, failure by ADMARC to influence price reduction in the retail markets means that consumers would only access the staple food commodity at higher prices. Similarly, maize producers would not be interested to trade with ADMARC at lower prices; this would make ADMARC fail to build food reserves for the nation, thereby forcing the consumers to buy the commodity at higher prices from the retail markets. Consequently, the observed maize market situation would likely worsen food insecurity among low income households in Malawi. This therefore, clearly shows that as a social protection agency, ADMARC would only have significant influence on producers if it purchased maize at a floor price that is competitive with retail market prices. Otherwise, ADMARC would need to have a strong financial muscle to effectively perform its social function on consumers. With huge competition from retail maize markets, the ceiling price offered by ADMARC to protect the consumers would mostly exacerbate food deficit situation in the country.

Finally, after running stability test on the VEC model, this study asserts that the estimated results can be trusted as reliable guides for policy direction. **Figure 2** shows a graph of the unit modulus after running the stability test of the VEC model. The results show that no root sits outside the unit modulus implying stability of the VEC model.

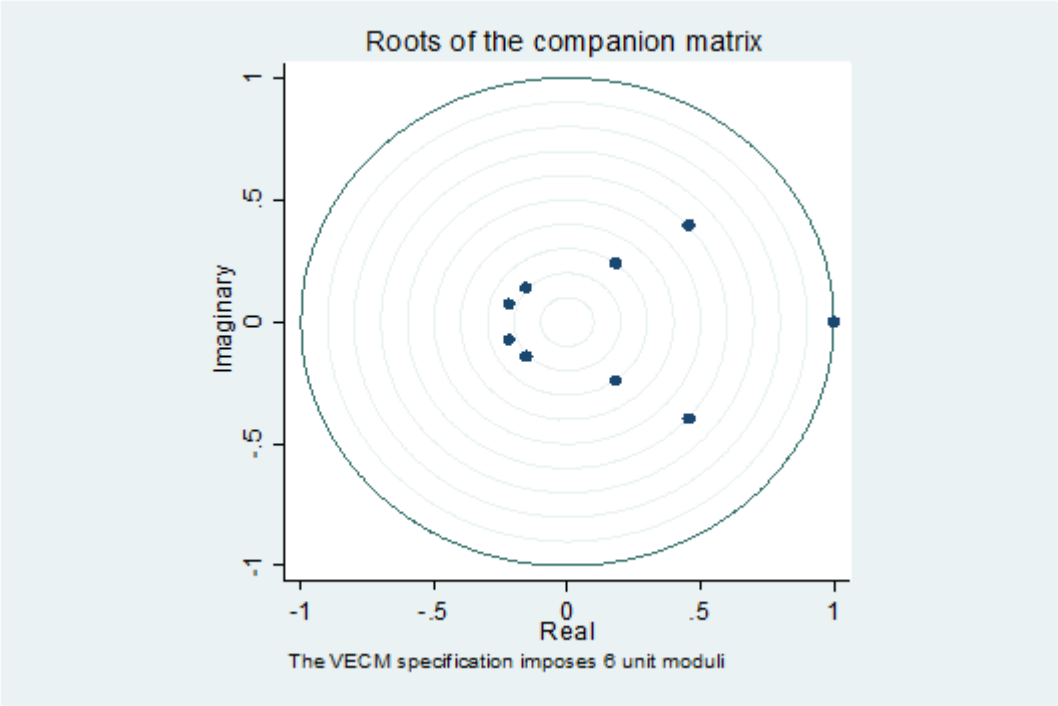

Fig.2 *Results of stability test of the VECM*

Source: Own graphic according to data by the Malawi Government's Ministry of Agriculture datasets from the Agricultural Market Information System (2005 – 2017)

4. Conclusion

The study employed Vector Error Correction model and Granger causality to test the influence of ADMARC maize prices on the commodity price in the major maize retail markets in Malawi. Focused retail maize markets included Chitipa, Mzimba, Dowa, Lilongwe, Ntaja, and Lunzu. A stationarity test was conducted using Augmented Dickey Fuller test. The study found that integration exists among the maize markets in Malawi –based on the co-integration test, which showed long-run relationships among the maize markets. However, in the short-run and with an exception of Dowa market, ADMARC fails to transmit price information to retail markets in Malawi. The long-run coefficients also showed that ADMARC set prices failed to significantly influence retail market prices, despite the existence of a one-way relationship from Lilongwe market, Ntaja market and Lunzu market to ADMARC, implying that ADMARC fails to influence retail market maize prices in Malawi. However, there exists strong integration among the retail markets both in the short and long-run. The retail maize markets in Malawi share a similar stochastic trend as observed by the co-integrating relationships revealed through the Johansen test. On top of that, price information was found to flow from retail markets to ADMARC market, and not the other way round. Thus, in its current status, ADMARC does not perform price leading function in the pricing of maize in Malawi and cannot be used to guarantee food security among low income households and neither can it protect the producers and consumers of the grain commodity.

The study hence proposes that the government should increase investment in ADMARC in order to enhance its competitiveness with retail markets and enable it achieve its mandate of transmitting prices favourable to both producers and consumers. The lower maize price offered by ADMARC fails to serve the majority of the low-

income consumers, and at most continues to attract vendors to purchase the commodity and re-sell it at higher prices in the retail maize markets in the country. As a social protection agency, ADMARC would have significant influence on producers if it purchased maize at a floor price that is competitive with retail market prices; this would require increased investment in ADMARC to make it financially strong. There is also a need to reduce administrative constraints that ADMARC faces in the procurement of maize; bureaucracy must be reduced and central and local governments must be empowered to provide administrative and conducive environment for promotion of functional maize markets in the country. Understanding the economic importance of fair markets and prices in the maize sector, we suggest that government efforts should focus on increasing the relative market power of producers along the supply chain. Embracing cooperative business approaches in the maize sector backed by a strong technical support could improve producer market power in the pricing of maize in Malawi.

Declaration of Conflicting interests

The authors hereby declare no conflict of interest with respect to the research, authorship and/or publication of this article.

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