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Market Liberalization and Spatial Market Integration: The case of Malawian maize Markets

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ABSTRACT

The role of markets in influencing food security cannot be overemphasized. Therefore it is important to understand how policies aimed at influencing market policy have performed. This paper studies how market liberalization policies have affected market efficiency in Malawian Maize markets. Using monthly time series price data from 12 markets in Malawi for the period from 1991 to 2016, market efficiency is measured using market integration as an indicator. Vector Error Correction models and Threshold auto regression models are used to measure the magnitude, direction and speed of market integration. We find that compared to maize market integration studies, market integration is indeed high, with average percent values of long run price transmission around 97% thereby supporting the law of one price. Speed of adjustment parameters for the Vector error correction model were on average 23% indicating a time frame of 4 months for market to return to equilibrium after a shock. The threshold auto regression model results indicate much faster speeds of adjustment, with an average time range of 2 weeks for half of the disequilibrium to be corrected. Therefore, Market Liberalization policies, even under frequent government intervention has led to increased market efficiency.

DEDICATION

To Dad

ACKNOWLEDGEMENTS

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My family for always cheering me on and encouraging me. All glory be to God always!!

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LIST OF ABBREVIATIONS

ADMARC	Agricultural Development and Marketing Corporation
BG	Breusch Godfrey
BoP	Balance of Payments
IFI	International Financial Institutions
IMF	International Monetary Fund
NFRA	National Food Reserve Agency
SAL	Structural Adjustment Loans
SAP	Structural Adjustment Programs
VECM	Vector Error Correction Model
WB	World Bank

1. INTRODUCTION

Food self-sufficiency has always been at the top of the agenda for the government of Malawi. Food self-sufficiency in Malawi is equated to availability and access to maize, the country's main staple food. Thus maize production and productivity levels are critical to ensuring that the country is food self-sufficient. The Malawian Government has focused on access to food for the whole population. To this end, the Government maintains some level of protection on maize trade in order to influence production and market decisions. However, the role of agricultural markets in influencing allocative efficiency cannot be underestimated.

The Agricultural sector in Malawi remains vital to the Malawian economy, contributing about 27% to GDP (International Monetary Fund, 2012). The significance of the agricultural sector to the economy has made it the subject of both internationally driven and domestic reforms, one of which was the International Monetary Fund (IMF) / World Bank (WB) driven Structural Adjustment Programs (SAP). The structural adjustment programs were a package of policies aimed at "changing the structure of the economy from government led to market driven"(Ng'ong'ola, 1996, pp 20). Although the structure of structural adjustment programs has evolved since 1981 when they were first implemented, the general idea has remained the same; minimizing the role of the state and allowing market forces to influence economic performance.

Market liberalization policies were part of the structural adjustment programs that the Malawian Government was required to implement under the Structural Adjustment Lending (SAL) facility. These policies required the government to remove restrictions on private sector participation in agricultural marketing and trade. The rationale of Market Liberalization policies was that opening up agricultural markets would increase market entry and investment in agricultural markets thereby inducing competition and allowing efficient markets to emerge (Delgado Christopher, Gabre-Madhin, Minot, & Johnson, 2002, pp 1). It is important to understand whether the implementation of market liberalization policies have indeed contributed to the emergence of efficient maize markets in Malawi.

Market integration is one of the measures of market efficiency. The study of market integration is important for several reasons. Firstly, understanding long-run relationships among spatially separated markets helps us evaluate the effectiveness of policies aimed at improving market performance. Specifically, market integration studies provide information on the magnitude, the speed, and the direction of price transmission. This information is useful for context- specific policy design and implementation. Previous studies have attempted to answer the broad question of the impact of market liberalization studies on market integration (for example, Goletti and Babu (1994); Ephraim Wadonda Chirwa (1999)). Both studies have concluded that structural adjustment programs have led to greater market integration. The aim of this paper is to expand on previous findings by studying a longer duration specifically focusing on how market performance has improved in the post reform period.

However, the study of reforms for the Malawian agricultural sectors is confounded by a number of factors, these include: the government's tendency for policy reversals, and the complexity of factors that affect the outcome so that it is difficult to isolate the effect of specific reforms from other processes affecting the broader economy(Jayne & Jones, 1997). Nevertheless, the understanding and isolation of individual policy effects is key to better policies and interventions, and why research on this subject is important.

1.1. Research Questions

1) What is the magnitude of price transmission across maize markets
2) What is the speed of price transmission across maize markets

2. LITERATURE REVIEW

2.1. Malawi

After independence in 1964, the Malawian economy was growing on average by 6% annually (Ephraim W Chirwa, 2004) .The growth was mostly attributed to good performance of the agricultural sector, particularly from tobacco export earnings. However, from 1979 the economy started stagnating and eventually declining. Several studies (Ephraim W Chirwa, 2004; Lele, 1990; Ng'ong'ola, 1996) have attributed the economic downturn to several factors. Firstly, the second oil price shock of 1979 which increased oil prices and ultimately increased the cost of imports. This was further compounded by the Mozambican civil war which started in 1977 and disrupted one of Malawi's main trade routes, further increasing the import costs. The studies further attributed the economic status to droughts in 1980 and 1981 which affected agricultural performance and reduced export levels and earnings. In addition, declining demand for tobacco, Malawi's main export crop, on the world market further reduced the nation's export earnings. The combination of these factors led to a widening balance of payments gap (BoP), worsening terms of trade and increasing public expenditure, all of which contributed to the declining economic growth rates.

The economic downturn was seen by International Financing Institutions (IFIs) such as the World Banks and the International Monetary Fund as resulting from structural weaknesses in the economy that needed to be corrected in order to get the economy back on its growth path. According to the World Bank (as cited in Ng'ong'ola, 1996), these structural weaknesses included, "a narrow export base, stagnant smallholder agricultural sector, heavy import dependence, inefficient public enterprises and weak resource management capacity". All these factors reduced the resilience of the economy to external shocks.

2.2. Structural Adjustment Lending Facility

The Structural Adjustment Lending Facility was introduced by the World Bank (WB) and International Monetary Fund (IMF) as a way of addressing the observed structural weaknesses in the economy. As a prerequisite for loan access, recipient nations were required to put in place a comprehensive package of reforms, SAPs, aimed at inducing efficiency (Holmes & Jonas, 1984). This efficiency was to be achieved through market rather than state-led approaches. Malawi was approved for its first structural adjustment loan in 1981. The loan conditions included agricultural policy reforms, fiscal and monetary reforms, trade policy reforms, and public enterprise reforms among others. In the agricultural sector, removal of price controls, market liberalization, the repeal of the special crops act, and the removal of price distortions resulting from government control of marketing were among the stipulated conditions (Ng'ong'ola, 1996). These policy conditions were designed to address the structural weaknesses in the economy by narrowing the BoP gap, improving terms of trade and reducing public expenditure (Lele 1990). More importantly, the policies were aimed at "ensuring that markets had a greater role in influencing prices, wages, resource allocation and the structure of production"(Lele, 1990). The reforms were also designed to alter producer and consumer incentives and ensure the emergence of efficient markets.

2.2.1. Market Liberalisation

Market liberalization policies were also aimed at changing the structure of agricultural markets with respect to the role of state corporations and the role of the private sector. This was to be done by significantly reducing the role of the state marketing institution, Agricultural Development and Marketing Corporation (ADMARC) in agricultural markets and removing price intervention policies, thus allowing markets to freely determine prices. Before liberalization, ADMARC had monopsony power in agricultural markets, particularly maize markets (Ephraim Wadonda Chirwa, 1999), the institution was also responsible for implementing government pricing policy (Ephraim Wadonda Chirwa, 1999, pp 5). IFIs however viewed state marketing boards as being inefficient and wasteful (Kherallah, Delgado, Gabre-Madhin, Minot, & Johnson, 2002). In addition, the stabilization role played by ADMARC was believed to be a drain on government resources and that reducing its operational scope would reduce public expenditure thereby cutting the government budget deficit. Furthermore, removal of price interventions would remove 'distortions' from prices and provide incentives production incentives for maize producers. Similarly, expanding the role of the private sector in agricultural markets was seen by the IFIs as a way of improving market performance; particularly because the private sector was seen as more efficient than the state.

At the inception of the SAPs, IFI's believed an outward based economic growth strategy which had worked for the industrialized countries could also work for Low Income Countries (Harrigan, 1997). The IFIs believed therefore by removing pricing constraints and increasing prices of exportable relative to maize under market liberalization, a more competitive pricing structure would begin to emerge and provide incentives for increased production of exportable crops. The result would be increased producer prices and economic growth (Kherallah et al., 2002; Lele, 1990). The increased returns to production could then make up for the loss that would arise from decreased production of maize through imports (Harrigan, 2003). The Malawian Government differs in this view, equating food security with food self-sufficiency (International Monetary Fund, 2012; Jayne & Jones, 1997). This difference in view has been the reason for the frequent policy reversals by the government.

2.3. Reform Implementation and Policy Reversals

The private sector was formally allowed participation in agricultural marketing from 1987 (Ephraim Wadonda Chirwa, 1999). However, the state has maintained some control over maize marketing through both quantity and trade restrictions during deficit years (Jayne, Sitko, Ricker-Gilbert, & Mangisoni, 2010; Myers, 2013). Trade restrictions are implemented by ADMARC and the National Food Reserve Agency (NFRA), the two institutions are responsible for importing maize during deficit periods in the domestic market. Although the operational scope of ADMARC has declined over the years, it still maintains a key role of implementing government pricing policies. However, reducing ADMARC's scope has reduced its effectiveness for price stabilization at a large scale.

Government intervention during the post liberalization period has been well documented. Government first intervened in markets after liberalization in 1996 by instituting a price band for maize which was not lifted until 2000 (Ephraim W Chirwa, 2004). The Government then restricted maize imports and exports following production decline and subsequent price spikes that followed a severe drought in 2001 (Cameron, 2015). During this period, only official imports through the Government were allowed and the imported maize stocks were released to the market at below market prices (Ephraim Wadonda Chirwa, 1999; Minot, 2010). After this, the Government next intervened in agricultural markets in 2005 following another weather shock that led to increased prices. During this period, the Government also restricted private maize trade domestically and as in 2001, later released imported maize to the domestic market at below market prices (Cameron, 2015). Another price spike occurred in 2007, prompting the government to restrict private trade (Cameron, 2015). The same pattern continued in 2011 when increasing prices resulted in maize export bans (Cameron, 2015). The Government maintains that government intervention is essential in order to protect consumers as inadequate trader competition leads to rising prices (Daudi, 2009). Nevertheless, agricultural markets are allowed to operate freely with occasional interventions at the discretion of the state.

2.4. Rationale

Well-functioning markets ensure that the implementation macro and sectoral policies regulate the incentives and constraints faced by micro-level decision makers (Barret & Mutambatsere 2008). Where well-functioning markets exist, government policies and the actions of the private sector influence decision making in order to achieve effective outcomes (Goletti & Babu, 1994). According to Goletti (1994) the success of liberalization and price stabilization policies depends on the strength of transmission of price signals among the markets in various regions of the country. A high degree of market integration is essential in ensuring that the right signals are transmitted and planned outcomes achieved.

It should be acknowledged that Malawi's Maize market is thin with a small proportion of total maize production marketed making maize prices highly elastic to production changes (Jayne et al. 2010). "A widely held opinion is that prices reported from a thin public market are not representative of those that would result from a larger population of buyers and sellers, either because of sample selection, or price manipulation through collusive agreements among buyers" (Nelson & Turner 1995). Where the market is thin therefore, the price transmission effect may not be as pronounced as in a market that is not thin. Jayne et al. (2010) found that approximately 56% of Malawian households bought grain in 2007 and only 10-15% of smallholder households sell grain during the course of the year. Chirwa (as cited in Jayne et al., 2010) postulated that the percentage of the buyers presented here may be underestimated for most years.

3. THEORY AND METHODS

In efficient markets, “prices reflect all the available information” (Lence & Falk, 2005). According to Rashid et al (2010), there are two types of market efficiency: arbitrage efficiency, which implies that market forces quickly work to eliminate any price differences through the actions of arbitrators and exchange efficiency which occurs when operational costs are kept at the lowest possible level given the transaction costs.

The focus of this paper is arbitrage efficiency. One way of understanding arbitrage efficiency is through market integration studies. Spatial market integration analyses are used to determine whether long run equilibrium price relationships exist across geographically separated markets. The presence of spatial arbitrage efficiency has important implications for food security in that food shortages do not persist as trade ensures that the system is quickly restored to equilibrium by trading away the imbalance across markets. Engle and Granger (1987) called this phenomenon, the error correction mechanism.

Methodologies for measuring market integration have evolved a lot in the last 30 years, moving from simple correlation studies to cointegration and more recently threshold cointegration and vector autoregressive methods. The cointegration methodology has been criticized by many authors [Balke and Fomby (1997); Baulch (1997); Barrett (1996);Barrett and Li (2002)] mainly because they “impose a linear approximation to a nonlinear process” (McNew, as cited in Barrett & Li, 2002). According to Barrett (2002) these nonlinearities could result from variations in trading patterns and costs; therefore, the magnitude of market integration is not invariant to these changes over time as is implicitly assumed in cointegration studies. Barret (2002) further suggests that not accounting for these nonlinearities affects the reliability of results.

However, the unavailability of trade and transfer cost data precludes their use in this study. Since there is still need to properly account for nonlinearities in trade, the threshold cointegration model developed by Myers (Myers, 2013) will be used in this study. This model has the advantage that it accounts for nonlinearities that could result from the interaction of price differences and transfer costs. In the model, Myers (2013, p.78) uses price differences rather than trade quantities to estimate the threshold, which is determined within the model.

3.1. Cointegration and Error Correction

The purpose of spatial market integration analysis is to test whether market pairs have a long run relationship. However, if the respective price series are non-stationary, ordinary regression methods usually give misleading results. Cointegration analysis provides a way of analysing such variables even though their non-stationarity implies that the two series will drift apart indefinitely in the long run. In Cointegration analysis, one has to make some assumptions about the behaviour of the variables when they deviate from equilibrium. Engle and Granger (1987, pp 253) postulated that these “deviations from equilibrium are stationary for co-integrated variables”. If this was not the case prices would drift apart indefinitely. This is the concept of error correction, which implies that the systems returns to the long run equilibrium after deviation. Cointegration analysis requires that the two variables be co-integrated of the same order (Engle & Granger, 1987).

The cointegration methodology was done in two steps using the Johansen Methodology. The model starts with a situation where the two variables are in equilibrium:

$$\beta_1 x_{1t} + \beta_2 x_{2t} = 0 \qquad 1$$

Deviations from equilibrium are denoted by e_t so that the system is in disequilibrium when $e_t \neq 0$, such that:

$$e_t = \beta_{xt} \qquad 2$$

Where: β denotes the vectors (β_1 and β_2)

x_t denotes the variables (x_{1t} and x_{2t})

e_t denotes the equilibrium error term

The first step in the analysis was to test all the individual price series for their order of integration. The Augmented Dickey Fuller (ADF) test was used to test for stationarity. The appropriate lag lengths were selected using Information criteria (LR, AIC, SBC). In cases where the information criteria gave conflicting results, the general to specific methodology was used. The rank of the unit roots were determined using the Johansen methodology. For co-integrated market pairs the parameters of interest were estimated using the Vector Error Correction

Model:

$$\Delta \boldsymbol{p_t} = \sum_{j=1}^{k-1} \Gamma \, \Delta \boldsymbol{p_{t-j}} + \alpha\beta' \, \boldsymbol{p_{t-k}} + \boldsymbol{\mu} + \boldsymbol{\epsilon_t} \quad 3$$

Where: $\sum_{j=1}^{k-1} \Gamma \, \Delta \boldsymbol{p_{t-j}}$ is the vector autoregressive (VAR) component in first differences

$\alpha\beta' \, \boldsymbol{p_{t-k}}$ is the error correction components

$\boldsymbol{p_t}$ is the vector of prices

$\boldsymbol{\mu}$ is a p*1 vector of constants

$\boldsymbol{\epsilon_t}$ is a p*1 vector of white noise error terms

Γ is a p*p matrix that represents short-term adjustments among variables across p equations at the *j*th lag

α is a p*r matrix of speed of adjustment parameters representing the speed of error correction mechanism

3.2.Threshold Cointegration

The threshold cointegration model assumes there are three regimes under which trade occurs. Regime 1 accounts for the situation where trade is discontinuous and Regimes 2 and 3 account for when trade is bidirectional. This means that in Regime 1 where no trade occurs prices in the two markets would be unrelated and continue to drift apart in the long run with no tendency to converge. Conversely, in regime 2 and 3 a change in the price spread that justifies trade would be exploited until the opportunity is arbitrated away and the systems adjusts back to equilibrium (Myers, 2013). Key to this analysis is the idea of thresholds in transfer costs and their effect on the occurrence of trade. The threshold is the point where transfer costs are higher than the price difference so that trade is not justified (Rashid & Minot, 2010). Myers (2013) classifies the three possible regimes under which trade occurs based on the price differences and the level of the threshold as follows:

$$|p_{jt} - p_{it}| < c_t \ if \ q_t = 0 \qquad (Regime\ 1) \qquad 4$$

$$|p_{jt} - p_{it}| = c_t \ if \ q_t > 0 \qquad (Regime\ 2) \qquad 5$$

$$|p_{jt} - p_{it}| = -c_t \ if \ q_t < 0 \qquad (Regime\ 3) \qquad 6$$

Where: $p_{jt}\ and\ p_{it}$ are prices in market *i* and *j* at time t

c_t is the marginal transfer cost at time t

q_t is the maize traded from market i to j (market j to market i if negative)

Regime 1 is the situation described above when the transfer costs are too high to justify trade and in Regimes 2 and 3 the price difference moves towards the transfer cost boundary (Myers, 2013, p. 78).

The TAR model is then specifies as follows for the three regimes:

$$\Delta d_t = \alpha + \sum_{k=1}^{K} \beta_k \Delta d_{t-k} + \varepsilon_t \ if \ |d_t| \le \tau_t \qquad (Regime\ 1) \qquad 7$$

$$\Delta(d_t - \tau_t) = \lambda(d_{t-1} - \tau_{t-1}) + \sum_{k=1}^{K} \gamma_k \Delta(d_{t-k} - \tau_{t-k}) + \varepsilon_t \ if \ d_t > \tau_t \ (Regime\ 2) \qquad 8$$

$$\Delta(d_t + \tau_t) = \lambda(d_{t-1} + \tau_{t-1}) + \sum_{k=1}^{K} \gamma_k \Delta(d_{t-k} + \tau_{t-k}) + \varepsilon_t \ if \ d_t < -\tau_t \ (Regime\ 3) \qquad 9$$

Where $d_t = p_{jt} - p_{it}$ is the price spread between the two markets

$\Delta d_t = d_t - d_{t-1}$ is the first difference operator

ε_t is the a zero mean serially uncorrelated error term

τ_t is the threshold variable that defines a boundary for when the price spread is too small to encourage trade (regime 1), versus when it is positive and large enough to encourage trade from location i to j (Regime 2), or negative and large enough (in absolute value) to encourage trade from *j* to *i* (Regime 3).

λ is the speed of adjustment parameter

3.3. Data Sources

Eleven markets covering the three regions of the country are used in this study. Data used are monthly maize prices measured in Malawi Kwacha for the period from January 1991 to December 2016. The Nominal prices were deflated using the Consumer Price Index for food obtained from the Malawi National Statistics Office. Historical maize price data was obtained from the Ministry of Agriculture and Food Security which collects weekly commodity prices for most markets in Malawi.

4. RESULTS AND DISCUSSION

4.1. Spatial Market Integration

4.1.1. Maize Price Intertemporal Analysis

The Data used in this paper consists of maize price series from 12 markets in Malawi namely Luchenza, Lunzu and Bangula in the southern region; Chimbiya, Lilongwe, Mitundu, Lizulu and Nkhotakota in the central region; and Karonga, Chitipa, Mzuzu and Rumphi in the Northern Region. Weekly market price data are collected by the Ministry of Agriculture and Food Security. To allow for a longer analysis period, the markets used in this study were those for which data was available for the entire study period. The price series had some missing values[a] which were interpolated using inverse distance weighed interpolation.

Table 1: Summary Statistics – Real prices (MWK/KG)

Variable	Obs	Mean	Std, Dev,	Min	Max	CV (%)
Bangula	312	46.6	29.7	8.8	147.5	63.8
Chimbiya	312	43.4	23.1	11.8	112.7	53.3
Chitipa	312	42.4	22.4	12.1	104.0	52.8
Karonga	312	47.4	23.9	14.4	125.0	50.4
Lilongwe	312	52.2	24.1	12.7	122.7	46.1
Lizulu	312	42.7	22.9	11.6	106.2	53.6
Luchenza	312	49.7	25.8	11.0	148.4	52.0
Lunzu	312	49.7	25.7	12.5	135.1	51.7
Mitundu	312	40.8	23.3	10.1	114.1	57.1
Mzuzu	312	47.3	21.9	18.5	127.9	46.4
Nkhotakota	312	49.9	24.2	14.2	126.9	48.5
Rumphi	312	48.2	28.8	11.8	161.2	59.7

Notes: CV-Coefficient of Variation

Table 1 presents the descriptive statistics for real maize prices for the 12 markets included in this study. Lilongwe and Lunzu, both city markets have high mean prices. This could be due to higher per capita incomes in the cities. Similarly, Nkhotakota has a high mean price which could be explained by its location and due to the fact the area has a different staple food and maize is grown at a small scale relative to rice. On the other hand, Mitundu has the lowest mean price but this is because it is a high maize producing area. Interestingly, Chitipa and Chimbiya markets, both located in border districts also have lower mean prices which could be explained by the maize imports through informal trade at the border. In terms of price variation, all markets show very high levels of price variation, the highest being in Bangula and Rumphi.

Figure 2 below shows the development of real prices in Malawi Kwacha/Kg over the period from 1991 to 2016. The price series share a common stochastic trend. A slight positive trend can also be observed in the data. Lunzu market is considered a central market in the Southern Region and it it can be observed from the graph that shocks originate from Lunzu market; Luchenza and Bangula markets are affected with a lag. The statistics from table 1 above indicate that the southern region markets have higher means which could be explained by the lower productivity of the southern region relative to the other two regions (Myers, 2013).

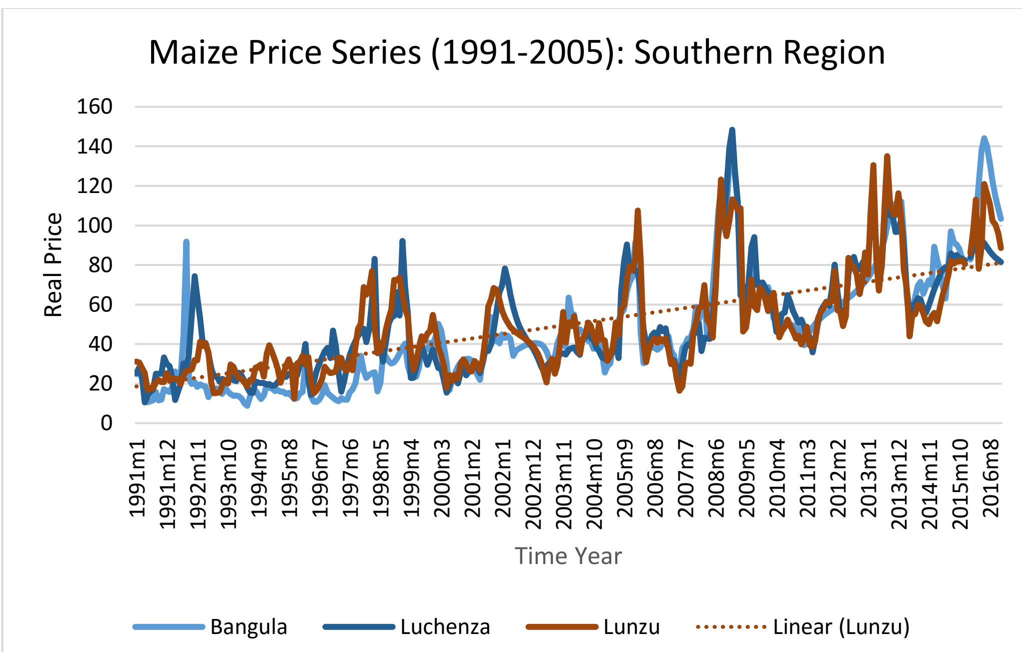

Figure 1: Deflated Maize Price Series for Bangula, Luchenza and Lunzu for the period 1991-2015

Figure 3 presents price series from the Central Region. The price series from the region also indicate a common trend. Mitundu market is a high maize producer and more likely to influence prices in the other markets. Admittedly, the Central Region is the highest maize producing region in Malawi (Cameron, 2015; Myers, 2013). The region also has lower mean prices compared to the other regions with the exception of Lilongwe market which has the highest mean price but lower relative variation. The series also has a slight upward trend.

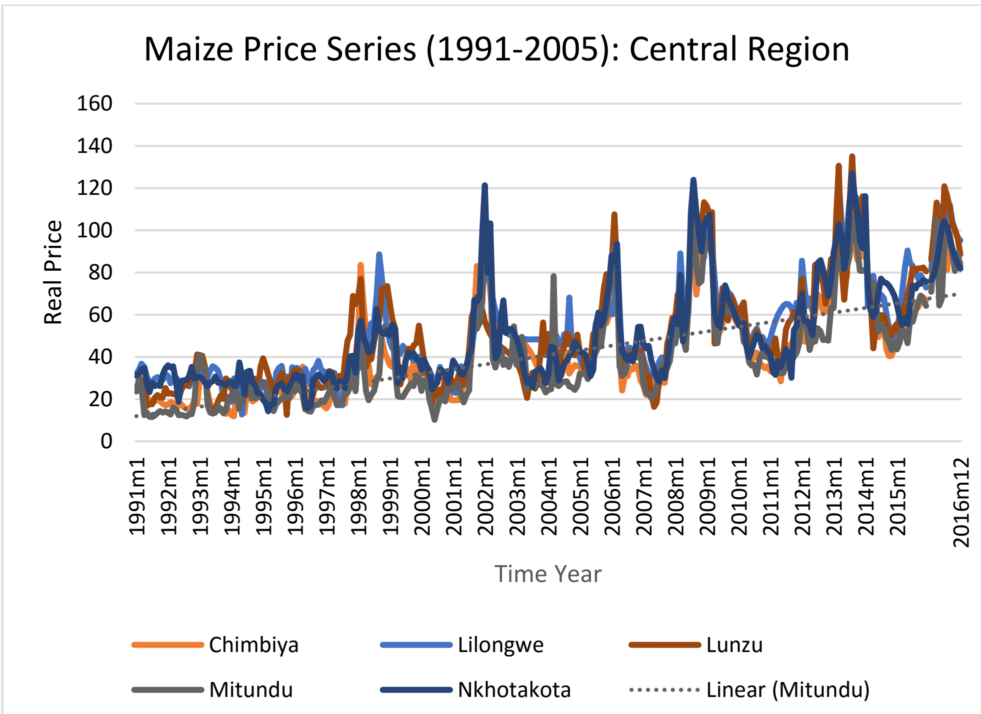

Figure 2: Deflated maize price series for Chimbiya, Lilongwe, Lunzu, Mitundu and Nkhotakota for the period 1991-2016

Figure 4 presents prices from the Northern Region markets. A common stochastic trend can also be observed across the market price series. Notably, there is lower price variability relative to the other regions. Maize imports from informal trade could partly explain the lower level of variability. In terms of productivity levels compared to the other regions, the Northern Region production levels vary but is mostly self-sufficient (Myers, 2013).

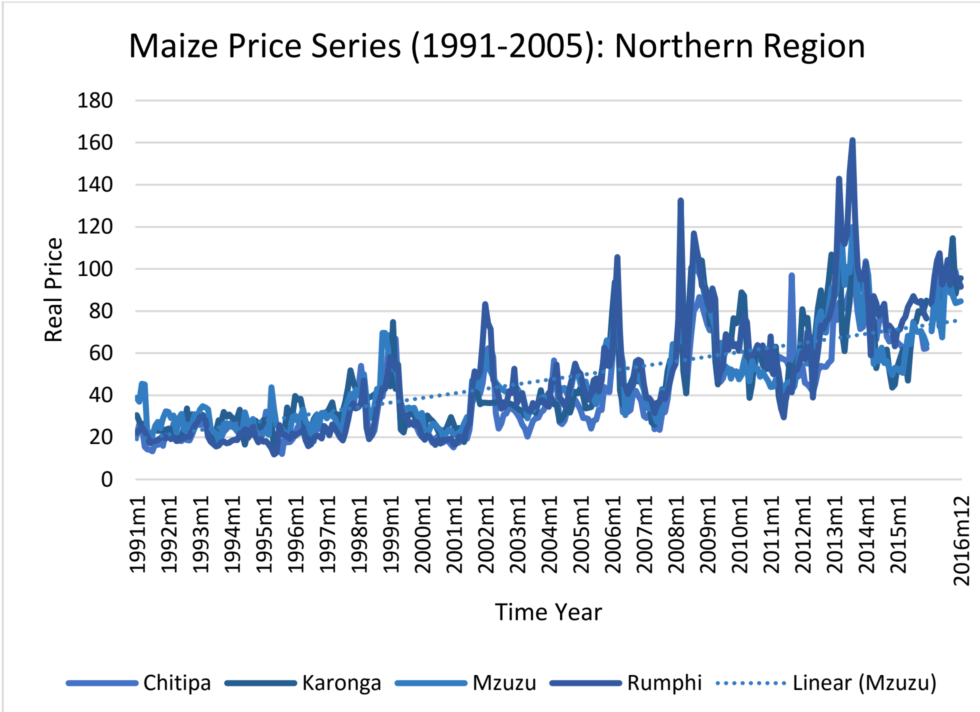

Figure 3: Price series for Chitipa, Karonga, Mzuzu and Rumphi for the period 1991-2016

The Market pairs depicted in all three figures all seem to follow similar stochastic trends with price series that do not drift too far apart for each market pair indicating price co-movement. Indeed, the bivariate correlation coefficient included in Table 7 in the appendix shows that the price series are highly correlated and that the correlation is invariant to distance. In addition, observed price Spikes are common to all markets and can be observed around the years 2001, 2005, 2008 and 2014. Droughts in 2001 and 2005 explain the price spikes for the first two years but the 2008 price spikes occurred despite record maize production levels in that year.

4.1.2. Maize Price Seasonal Analysis

Figure 5 below shows the price variation by month. A general trend can be observed across the markets. Prices are high in the growing season between January and March, usually peaking in March. Then, price begin to drop as Maize is being harvested from April due to the increased supply. However, prices begin to rise again typically from July as supply will have started to decline by then. The prices then remain relatively high through the dry season towards the end of the year.

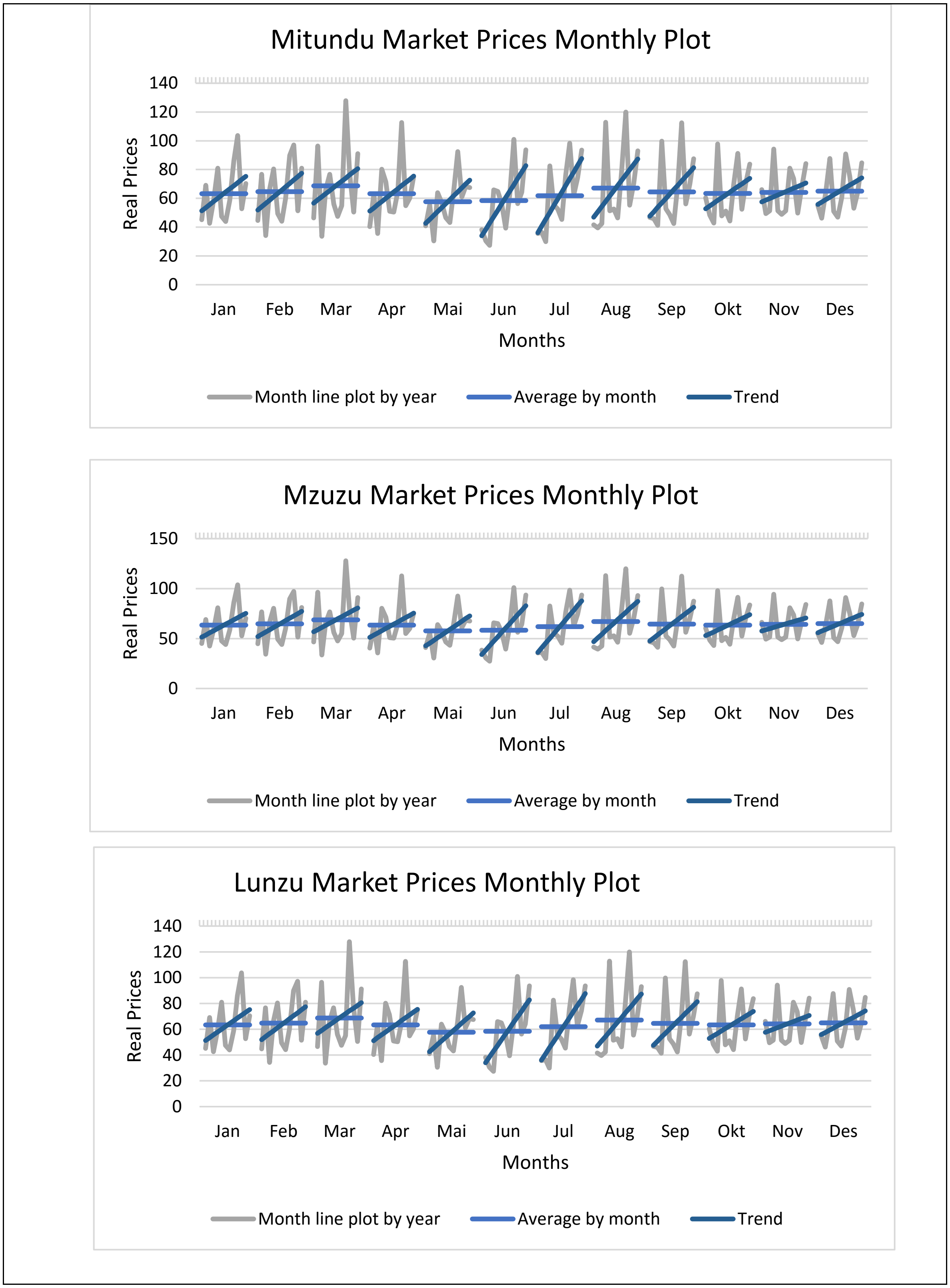

Figure 4: Monthly sub-series plots for Maize prices showing monthly price variation for the period 2005-2016 for major regional markets

4.1.3. Price Differences

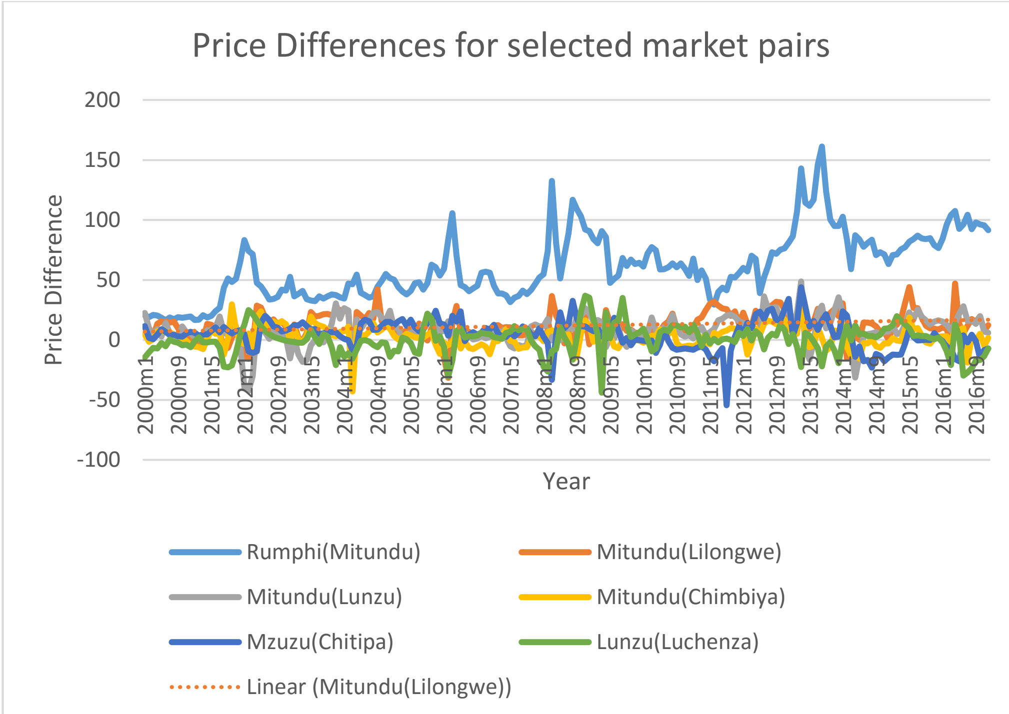

Figure 5: Price Difference across market pairs

The behaviour of price differences across time and space provide useful insights on the long run behaviour of markets. For instance, price series with mean values close to zero are usually an indication of efficient markets where price differences are quickly traded away to return price levels to equilibrium. Figure 5 above shows the trend in price differences across time for some markets. Generally, most price series are close to zero during the entire period with the exception of Rumphi and Mitundu markets. But this difference could be explained by the fact that the markers are located far apart.

4.2. Cointegration Analysis

According to Engle and Granger (1987), a necessary condition for two variables to be integrated is that they should be co-integrated of the same order. The Augmented Dickey Fuller (ADF) test was used to determine the order of integration. The results for the ADF test are presented in Table 1 below. The null hypothesis for the ADF test was that the series has a unit root and is therefore nonstationary. However, the model did not provide enough evidence to reject the Null hypothesis for all the markets analysed. All the variables were nonstationary in the levels but are stationary in their first differences. Therefore all the variables are integrated of order 1.

Table 2: ADF Test for Unit Roots

Test	Level	First Differences
N = 312	Augmented Dickey Fuller t-statistics (p)	Augmented Dickey Fuller t-statistics (p)
Rumphi	-1.307 (19)	-16.124 (1) ***
Nkhotakota	-2.708 (13)	-13.177 (1) ***
Mzuzu	-1.494 (19)	-8.165 (4) ***
Mitundu	-1.726 (20)	-10.904 (3) ***
Lunzu	-1.839 (19)	-12.454 (2) ***
Luchenza	-2.251 (16)	-9.559 (3) ***
Lizulu	-2.495 (15)	-11.487 (1) ***
Lilongwe	-1.800 (15)	-12.543 (2) ***
Karonga	-1.869 (14)	-4.612 (12) ***
Bangula	-1.228 (9)	-7.845(9) ***
Chitipa	-1.389 (13)	-10.413 (3) ***
Chimbiya	-2.397 (15)	-11.882 (2) ***

Notes:

1. ***,** and * imply significance at the 1%, 5% and 10% level respectively
2. The null and alternative hypothesis are respectively H_0 : The series has a unit root and H_1: The series is stationary
3. p is the number of lags
4. The lags for the Augmented Dickey Fuller are determined using information criteria (LR, AIC, SBC)

The Johansen cointegration test results for selected market pairs are reported in table 2. Since we are testing pairwise co-integration, the two hypotheses are that there is no co-integrating relationship among the two markets and that there is one co-integrating relationship. The values of the trace statistic in the null hypothesis that r=0 are all greater than the 95% critical value, therefore we reject the null hypothesis. In contrast, the values of the trace statistic are all less than the critical values at the 95% level so we cannot reject the null hypothesis of the existence of a co-integrating relationship. Pairwise trace statistics for all possible market pairs are reported in table 8 in the appendix. The pairwise results indicate a strong support for cointegration with 91% of the market pairs showing a long-run equilibrium relationship.

Table 3: Johansen Cointegration Test Results for selected market pairs based on likelihood of trade

Market pairs	Number of lags in VEC	Trace Statistic (r=0)	Trace Statistic (r=1)
Mitundu/Lilongwe	3	61.9684	5.2219*
Mitundu/ Lunzu	4	53.0454	7.8466*
Mitundu/Mzuzu	5	33.6097	6.7964*
Mitundu/Chimbiya	3	65.3003	6.5769*
Mitundu/Lizulu	3	77.7857	9.3846*
Lilongwe/Lunzu	6	52.0718	7.5466*
Lilongwe/Mzuzu	1	80.6705	6.0726*
Lilongwe/Chimbiya	3	49.7202	4.5809*
Lilongwe/Lizulu	6	62.9489	6.9128*
Lunzu/Luchenza	4	54.5943	7.8335*
Lunzu/Bangula	3	43.5776	6.6107*
Mzuzu/Rumphi	3	64.7293	4.9416*
Mzuzu/Karonga	2	75.8128	6.3815*
Mzuzu/Nkhotakota	5	37.5678	6.0841*
Mzuzu/Chitipa	4	28.8048	3.8162*
Chimbiya/Lizulu	3	54.2147	7.6263*
Karonga/Rumphi	3	47.2747	4.4594*
Karonga/Chitipa	3	46.7447	4.8041*

Notes:

1. Null hypothesis- rank=1
2. Lag lengths in vector auto-regressions were selected using information criteria (LR, AIC, SBC)
3. *, ** and *** imply significance at the 1%, 5% and 10% level, respectively.
4. 95% critical values for r=0 and r=1 are 19.96 and 9.42 respectively

Since we have established the existence of co-integrating relationships, the VECM can be used to estimate the parameters of interest. Table 3 below presents the results for the Johansen Vector Error Correction Model (VECM). The error correction model is useful for understanding how current variables change in response to the disequilibrium in the previous period. Important parameters in the Johansen test are: the co-integrating vector parameter, β; the speed of adjustment coefficients, α; and the short-run coefficients.

Table 4 below presents the results the results of the VECM model. The speed of adjustment parameters are presented in columns (3) and (4) in table 4. It is important to note that the speed of adjustment parameters for market *i* are negative and positive for market j. This conforms to the assertion that the two price series should have differing signs to ensure "direct convergence to long-run equilibrium" (Enders, 2015, pp363). All of the market pairs conform to this assertion with the exception of Mitundu and Mzuzu. The speed of adjustment coefficients range from 8% for Mzuzu and Chitipa, to 48% for Mitundu to Lizulu. This means it would take over a year for prices to fully adjust for Mzuzu and Chitipa while it would take just over two months for full adjustment for Mitundu and Lizulu markets. Adjustment from market *j* to market *i* lie within the range of 7% to 40% for Mitundu / Lunzu, and Rumphi/ Mzuzu market pairs respectively. Average levels of adjustment for the analysed market pairs are 26% and 21%. Generally, correction of prices to restore equilibrium takes around 4 months.

The co-integrating vector parameters are presented in column (5). These parameters provide information on the level of price transmission across markets. The market *i* coefficient is normalized to 1 in this model so that the coefficients reported in this table show the magnitude of the price change that is transmitted to market *j*. The percentage of price transmission is between 76% for Mzuzu/Rumphi and 113% for Lilongwe/Lizulu. The average level of long run transmission is 97% for the analysed markets. These results are consistent with the law of one price.

The short run coefficients show period specific adjustment in markets *i* and *j* as a results of shocks in one of the markets. To ensure that the residuals approximate white noise processes the Breusch Godfrey (BG) LM test was used to perform diagnostic tests on the residuals. The results of the BG LM test are presented in column (8) and indicate that there was no residual autocorrelation and that the lag lengths were correctly specified.

Table 4: Vector Error Correction Model Results

Market pairs (*i*/*j*)	p	Speed of adjustment α_i	Speed of adjustment α_j	CI vector β_j	Short-Run Coeff (*i*)	Short-Run Coeff (*j*)	LM test statistic (p)
Mitundu/Lilongwe	3	-0.37 (0.61)***	0.12 (0.05)**	-0.91 (0.05)***	0.20 (0.07)***	-0.13 (0.08)*	0.37
Mitundu/ Lunzu	4	-0.33 (0.07)***	0.07 (0.08)	-0.93 (0.05)***	0.01 (0.08)	0.03 (0.08)	0.58
Mitundu/Mzuzu	5	-0.32 (0.07)***	-0.00 (0.05)	-0.97 (0 .07)***	0.15 (0.08)*	-0.12 (0.09)	0.98
Mitundu/Chimbiya	3	-0.42 (0 .08)***	0.11 (0.07)	-0.97 (0.04)***	0.12 (0.08)	0.06 (0.09)	0.19
Mitundu/Lizulu	3	-0.48 (0.08)***	0.14 (0.06)**	-0.99 (0.03)***	0.14 (0.08)*	0.13 (0.1)	0.15
Lilongwe/Lunzu	6	-0.19 (0.05)***	0.28 (0.07)***	-1.04 (0.05)***	-0.1 (0.07)	0.24 (0.06)***	0.25
Lilongwe/Mzuzu	1	-0.18 (0.05)***	0.22 (0.04)***	-1.1 (0.05)***			0.27
Lilongwe/Chimbiya	3	-0.20 (0.05)***	0.18 (0.05)***	-1.1 (0.06)***	-0.08 (0.07)	0.21 (0.07)***	0.49
Lilongwe/Lizulu	6	-0.18 (0.07)***	0.3 (0.06)***	-1.13 (0.04)***	-0.05 (0.08)	0.12 (0.08)	0.60
Lunzu/Luchenza	4	-0.12 (0.05)**	0.26 (0.05)***	-1.01 (0.06)***	-0.09 (0.07)	0.14 (0.06)	0.11
Lunzu/Bangula	3	-0.18 (0.04)***	0.22 (0.05)***	-0.82 (0.05)***	-0.01 (0.06)	0.08 (0.05)	0.85
Mzuzu/Rumphi	3	-0.21 (0.07)***	0.40 (0.09)***	-0.76 (0.03)***	-0.05 (0.07)	0.2 (0.05)***	0.28
Mzuzu/Karonga	2	-0.24 (0.05)***	0.23 (.06)***	-0.94 (0.04)***	-0.06 (0.06)	0.14 (0.05)***	0.52
Mzuzu/Nkhotakota	5	-0.09 (0.05)*	0.29 (0.07)***	-0.97 (0.06)***	-0.12 (0.07)	0.18 (0.06)***	0.68
Mzuzu/Chitipa	4	-0.08 (0.05)	0.19 (0.05)***	-0.99 (0.08)***	-0.10 (0.07)	0.2 (0.07)***	0.15
Chimbiya/Lizulu	3	-0.2 (0.07)***	0.22 (0.06)	-1.04 (0.04)***	0.00 (0.08)	0.23 (0.09)***	0.18
Karonga/Rumphi	3	-0.16 (0.06)***	0.20 (0.06)***	-0.8 (0.05)***	0.11 (0.07)	-0.24 (0.07)***	0.32
Karonga/Chitipa	3	-0.13 (0.05)**	0.18 (0.04)***	-1.03 (0.07)***	0.04 (0.07)	-0.07 (0.08)	0.14
Average		**0.26**	**0.21**	**0.97**			

Notes:

1. *, ** and *** imply significance at the 1%, 5% and 10% level, respectively.
2. Number of lags (p) determined using information criteria (LR, AIC, SBC)
3. Breusch-Godfrey Test for autocorrelation – The null hypothesis H_0: no autocorrelation against the alternative of H_1: autocorrelation
4. β_{j} – Cointegration

4.2. Threshold Auto Regression Model Results

The results for the threshold auto regression model are presented in table 5 below.

Table 5: Threshold Cointegration Results

Market pair	λ	Half-life	δ_0	δ_1	Mean (δ)	R^2	LM Stat
Mitundu-Chimbiya	-0.05(0.01)***	13.51341	9.1	9.8	9.1	9.8	0.49
Mitundu-Lilongwe	-0.06(0.00)***	11.20231	19.7	17.2	19.7	17.2	0.61
Lilongwe-Lunzu	-0.095(0.00)***	6.943948	13.9	12.2	13.9	12.2	0.45
Chitipa-Karonga	-0.04(0.00)***	16.97975	19.0	19.0	19.0	19.0	0.52
Mzuzu-Karonga	-0.07(0.01)***	9.551338	11.1	11.2	11.1	11.2	0.28
Lunzu-Luchenza	-0.061(0.01)***	11.01286	12.6	11.37	12.6	11.37	0.84
Mzuzu-Nkhotakota	-0.09(0.01)***	7.349615	12.3	12.3	12.3	12.3	0.46
Mitundu-Lizulu	-0.04(0.01)***	16.97975	9.62	10.16	9.62	10.16	0.66
Karonga - Rumphi	-0.06(0.00)***	11.20231	12.9	2.5	12.9	2.5	0.21
Lunzu-Bangula	-0.127 (0.01)***	4.98	16.1	11.8	16.1	11.8	0.28
Mitundu-Mzuzu	-0.06 (0.01)***	11.20	13.28	15.15	13.28	15.15	0.67

Notes: Half- life formula = $\ln(0.5)/\ln|\lambda+1|$
λ – Speed of adjustment parameter
δ_0 – Threshold at the beginning of the study period
δ_1 – Threshold at the end of the period
LM statistic- Breusch Godfrey LM test for serial correlation, Null hypothesis: No serial autocorrelation

According to Myers (2013) smooth adjustment requires that the speed of adjustment parameter (λ) lie within the ranger of 0 and -1. Notably, all the speed of adjustment parameters estimated in this model are within this range, so we know that deviations from equilibrium are smoothly corrected. The half-life parameter in this case has a weekly interpretation because the price data used are average weekly prices[1].

The speed of adjustment parameters have the interpretation of half-life when calculated using the formula above. The half-life shows the amount of time it takes for half of the effects of a shock in market *i* to be transmitted to market *j*. The half-lives vary with the market pair and the lowest speed of adjustment parameter is for Lunzu and Bangula and the highest are for Mitundu - Lizulu; and Chitipa – Karonga. We can see that distance is not a major determinant for the speed of adjustment parameters as some market pairs that are located near to each other, like Mitundu and Lilongwe have high half-lives. Lunzu and Bangula are separated by an approximate distance of 144 kilometres, yet it can be seen that it takes 1.2 weeks for half of the shocks transmitted to Bangula from Lunzu market to be corrected. Overall it takes at most, just over a month for the half of the disequilibrium caused by shocks in market $_i$ to be corrected in market j. These estimated half-lives are higher than those estimates by (Myers, 2013). However, his analysis used weekly rather than monthly price data and he used nominal rather than real prices, which could explain the differences for similar markets that were considered. Persistent high price differences over time warrant further investigation to determine the causes of the price differences, information that is useful for policy makers in efforts to improve market efficiency.

The threshold variable presented in the table below indicated the thresholds below which trade is unprofitable and under which rational arbitrators do not engage in trade. The average threshold variable thus presents an estimate of total returns for arbitrators (Myers, 2013). According to Myers (2013), in efficient markets the threshold value provides a good estimate of transaction costs. This is because under operational efficiency, price differences should approximate transaction costs. The results in the table below indicate the estimated threshold values at real values. Again the results are invariant to distance, as Lilongwe and Mitundu, approximately 43 kilometres apart have the largest average threshold value in sampled market pairs. Since the threshold variable is derived from the price difference, the threshold variable indicates that absolute convergence does not occur across these markets. It could also be an indication of higher than normal returns to trade.

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[1] To account for data aggregation effects, the half-life which is applicable for weekly data is converted to a monthly measure.

The threshold model used here shows that accounting for nonlinearities in the direction of trade and the existence of trade based on market prices shows different results than using just the Vector Error Correction Model for analysis. Indeed when we account for the nonlinearities we find that speeds of adjustment are much faster than were estimated in the vector error correction model. The model also has the additional benefit of estimating threshold values at the beginning and at the end of the sample and therefore provides insight on how the threshold variable is changing with time.

In terms of model adequacy, the threshold auto regression model performs well. The Breusch Godfrey test for serial correlation indicated that the residual are not serially correlated. Market pairs with serially correlated error terms were removed from the analysis. All the market pairs presented in Table 5 have no residual correlation at the first lag.

5. CONCLUSION AND POLICY IMPLICATIONS

This study employed Co-integration and Vector Error Correction Models to analyse spatial integration among selected maize markets in Malawi using monthly price data from 12 markets. The Augmented Dickey Fuller Unit Root test shows that all the market price series are nonstationary in their levels but stationary in the first differences. Cointegration tests indicate a co-integrating relationship between all the market pairs tested. This shows that the market performance is improving with price transmission occurring across more markets across markets. The results from the vector error correction model show strong evidence of the law of one price with the co-integrating coefficient being close to 1 (0.97). These results indicate strong price transmission across markets. High market integration levels have several implications for the government, and maize producers and consumers.

Improved market integration is important in order to improve the resource allocation role of markets.   This allocation role is particularly important for staple food markets. In a market with few producers and more buyers, distributive mechanisms have to be efficient in order to ensure that the market plays a key role in bringing about food security. Furthermore, in highly integrated markets shocks do not persist which is beneficial for low income residents who depend on the markets to supplement consumption. Moreover, since successful market integration should reduce price variability and reduce the risk for producers, especially those located in rural areas. Therefore, the high levels of market integration are important for advancing for food security agenda.

Market integration also has implications for the effectiveness and the cost of government price stabilisation efforts. The choice, effectiveness and cost of policy implementation are dependent on the levels or arbitrage and exchange efficiency. That is, where markets are efficient, stabilisation through maize stocks would be an efficient mechanism of improving access across deficit areas. Additionally, the costs of stabilization would be lower because of the information is spread quickly allowing for more informed decisions and better outcomes.

Market integration will also influence the role of the private sector in maize markets. Highly integrated maize markets provide incentives for the private sector to expand the role in agricultural markets. However, as (Barrett, 1996) claimed, it is difficult to fully understand the role of price transmission in the broader policy arena without accounting for trade and transfer cost data

6. APPENDIX

Table 6: Missing Value Summary

Market	Missing	Total	Percent Missing
Bangula	106	312	33,97
Chimbiya	25	312	8,01
Chitipa	31	312	9,94
Karonga	62	312	19,87
Lilongwe	73	312	23,4
Lizulu	28	312	8,97
Luchenza	96	312	30,77
Lunzu	33	312	10,58
Mitundu	12	312	3,85
Mzuzu	33	312	10,58
Nkhotakota	48	312	15,38
Rumphi	28	312	8,97

Figure 6: Map showing analysed markets

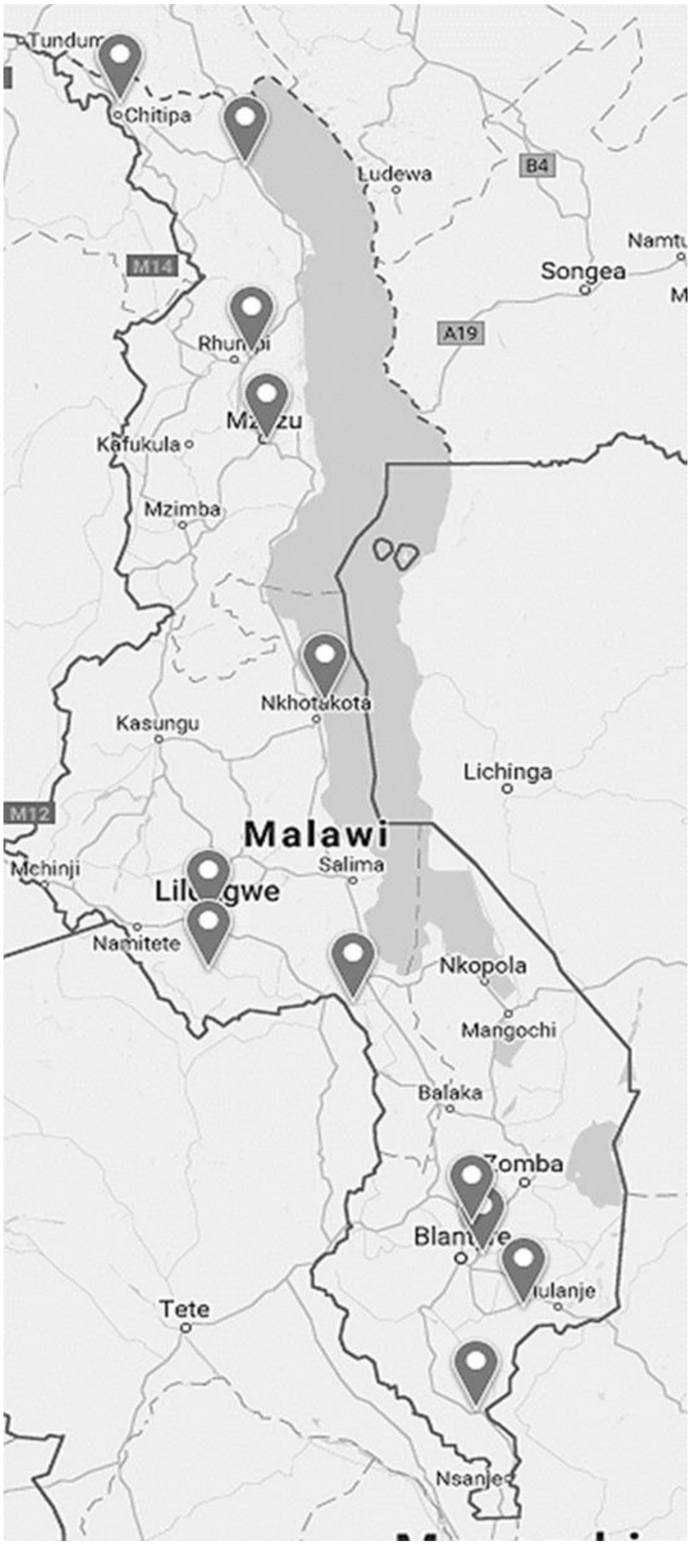

Table 7: Bivariate Correlation Coefficient

	Bangula	Chimbiya	Chitipa	Karonga	Lilongwe	Lizulu	Luchenza	Lunzu	Mitundu	Mzuzu	Nkhotakota	Rumphi
Bangula	1											
Chimbiya	0.83	1										
Chitipa	0.83	0.84	1									
Karonga	0.85	0.85	0.87	1								
Lilongwe	0.85	0.91	0.8	0.86	1							
Lizulu	0.86	0.94	0.86	0.85	0.90	1						
Luchenza	0.86	0.86	0.83	0.86	0.86	0.89	1					
Lunzu	0.87	0.91	0.85	0.90	0.89	0.92	0.90	1				
Mitundu	0.85	0.93	0.86	0.85	0.89	0.94	0.86	0.90	1			
Mzuzu	0.84	0.89	0.89	0.90	0.91	0.90	0.86	0.90	0.89	1		
Nkhotakota	0.85	0.91	0.84	0.85	0.90	0.92	0.88	0.89	0.91	0.90	1	
Rumphi	0.8	0.88	0.93	0.89	0.91	0.88	0.85	0.86	0.89	0.93	0.90	1

Table 8: Bivariate Johansen Trace Statistics

	Bangula	Lizulu	Nkhotakota	Rumphi	Chitipa	Karonga	Luchenza	Chimbiya	Mzuzu	Lunzu	Lilongwe	Mitundu
Bangula												
Lizulu	5.9558*											
Nkhotakota	6.4203*	7.0562*										
Rumphi	4.0922*	4.8542*	6.0681*									
Chitipa	5.0540*	4.4812*	5.2629*	5.3202*								
Karonga	5.1929*	3.3260*	3,3333	4.4594*	4.8041*							
Luchenza	5.9998*	8.0869*	7.0575*	4.0024*	5.1918*	3.1710*						
Chimbiya	4.9280*	7.6263*	5.7857*	4.8720*	5.4375*	2,8978	6.1250*					
Mzuzu	5.7540*	5.1106*	6.0841*	4.9416*	3.8162*	6.3815*	4.3903*	4.4198*				
Lunzu	6.6107*	9.2869*	9,4415	2.7253*	5.6663*	3.2466*	7.8335*	3,7841	6.6286*			
Lilongwe	4.5368*	6.9128*	7.4910*	3.8048*	3.1060*	3,7605	7.6784*	4.5809*	6.0726*	7.5466*		
Mitundu	1.7385*	9.3846*	12,4977	5.0027*	4.3779*	3,2133	7.0620*	6.5769*	6.7964*	7.8466*	5.2219*	

7. REFERENCES:

Balke, N. S., & Fomby, T. B. (1997). Threshold Cointegration. *International Economic Review, 38*(3), 627-645. doi:10.2307/2527284

Barrett, C. B. (1996). Market analysis methods: are our enriched toolkits well suited to enlivened markets? *American Journal of Agricultural Economics, 78*(3), 825-829.

Barrett, C. B., & Li, J. R. (2002). Distinguishing between equilibrium and integration in spatial price analysis. *American Journal of Agricultural Economics, 84*(2), 292-307.

Baulch, B. (1997). Testing for food market integration revisited. *The journal of development studies, 33*(4), 512-534.

Cameron, A., Gourichon, H. and Morales, C., Rome. (2015). *Analysis of price incentives for maize in Malawi.* Retrieved from

Chirwa, E. W. (1999). Food marketing reforms and integration of maize and rice markets in Malawi. *Zomba, Malawi: University of Malawi*.

Chirwa, E. W. (2004). *Effects of Economic and Trade Policy Reforms on Food Security in Malawi*. Retrieved from

Daudi, A. (2009). An assessment of Agricultural reforms for enhancing agricultural productivity. Retrieved from https://www.google.no/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjRwPa2vKbLAhVkOJoKHaYOAwQQFgggMAA&url=http%3A%2F%2Fwww.un.org%2Fesa%2Fdsd%2Fdsd_aofw_wat%2Fwat_pdfs%2Fmeetings%2Fws0109%2F1_Malawi_Daudi.pdf&usg=AFQjCNEdbenR8x6rmKa-12kXHpkvxRnrYQ&sig2=sHfP2fJEhl7esHfl9nJSYw&bvm=bv.115339255,d.bGs

Delgado Christopher, L., Gabre-Madhin, E. Z., Minot, N., & Johnson, M. K. (2002). The road half traveled: agricultural market reform in Sub-Saharan Africa.

Enders, W. (2015). *Applied Econometric Time Series* (Fourth Edition ed.). New Jersey: John Wiley and Sons, Inc.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251-276.

Goletti, F., & Babu, S. (1994). Market Liberalization and integration of maize markets in Malawi. *Agricultural economics, 11*(2-3), 311-324.

Harrigan, J. (1997). Modelling the impact of world bank policy-based lending: The case of Malawi's agricultural sector. *The journal of development studies, 33*(6), 848-873.

Harrigan, J. (2003). U-Turns and Full Circles: Two Decades of Agricultural Reform in Malawi 1981–2000. *World Development, 31*(5), 847-863. doi:http://dx.doi.org/10.1016/S0305-750X(03)00019-6

Holmes, R., & Jonas, O. (1984). *Trade liberalization in structural adjustment lending*. Retrieved from Washington D.C: http://documents.worldbank.org/curated/en/266931467980544602/Trade-liberalization-in-structural-adjustment-lending

International Monetary Fund. (2012). *malawi growth and development strategy*. Retrieved from

Jayne, T. S., & Jones, S. (1997). Food marketing and pricing policy in Eastern and Southern Africa: A survey. *World Development, 25*(9), 1505-1527. doi:http://dx.doi.org/10.1016/S0305-750X(97)00049-1

Jayne, T. S., Sitko, N., Ricker-Gilbert, J., & Mangisoni, J. (2010). *Malawi's Maize Marketing System*. Retrieved from http://purl.umn.edu/62162

Kherallah, M., Delgado, C. L., Gabre-Madhin, E. Z., Minot, N., & Johnson, M. (2002). *Reforming agricultural markets in Africa: achievements and challenges*. Baltimore MD: Johns Hopkins University Press.

Lele, U. (1990). Structural Adjustment, Agricultural Development and the Poor: Some Lessons from the Malawian Experience. *World Development*, *18*(9), 1207-1219.

Lence, S., & Falk, B. (2005). Cointegration, market integration, and market efficiency. *Journal of International Money and Finance, 24*(6), 873-890. doi:https://doi.org/10.1016/j.jimonfin.2005.05.002

Minot, N. (2010). *Staple food prices in Malawi*. Retrieved from

Myers, R. J. (2013). Evaluating the effectiveness of inter-regional trade and storage in Malawi's private sector maize markets. *Food Policy, 41*, 75-84. doi:http://dx.doi.org/10.1016/j.foodpol.2013.04.007

Ng'ong'ola, D. (1996). Analysis of Policy Reform and Structural Adjustment Programmes in Malawi, with emphasis on agriculture and trade.

Rashid, S., & Minot, W. N. (2010). *Are Staple Food Markets in Africa Efficient? Spatial Price Analyses and Beyond*. Paper presented at the COMESA policy seminar Maputo, Mozambique. https://www.researchgate.net/profile/Nicholas_Minot/publication/46470919_Are_Staple_Food_Markets_in_Africa_Efficient_Spatial_Price_Analyses_and_Beyond/links/02e7e526991114bad2000000/Are-Staple-Food-Markets-in-Africa-Efficient-Spatial-Price-Analyses-and-Beyond.pdf