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Research Article

Transmission of South African maize prices into Botswana markets: an econometric analysis

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The international prices of food commodities increased sharply between 2005 and 2008 and continued to rise. Over this period, international maize prices have also increased by 80 percent. Botswana imports majority of food items and has been witnessing unprecedentedly higher prices of food items. Maize is one of the staple foods in Botswana and, mostly imported from South Africa to meet the local demand. Little information is available on the transmission of maize prices from South African market into the Botswana market therefore, this study was conducted. The cointegration techniques and the error correction model (ECM) were employed to analyse the transmission of South African maize prices into the Botswana market. It was concluded that the two markets have a steady relationship and the markets are functioning effectively. Findings revealed that a long-run steady state of equilibrium existed between the South African and Botswana maize prices. It was recommended that local production of not only maize, but also other substitute staple foods such as sorghum should be promoted to reduce imports and, therefore, avoid food insecurity especially when maize price increases in South Africa.

Keywords: Cointegration, Error Correction Model, international market, maize market, maize price, price transmission.

INTRODUCTION

Maize is the most important staple food grain produced and consumed in Botswana. It provides high percentage of the daily calories in most of the diets of consumersaccounting for more than half of the average daily calorie intake (Lekgari and Setimela, 2004). Maize is grown in all regions of Botswana. It is cultivated at subsistence scale as well as commercial scale. Majority of maize is produced by smallholder producers for subsistence to semi-subsistence purposes through rain fed arable agriculture. Maize consumption in Botswana is estimated at 125,000 metric tons which are compared to the low local production about 13,000 metric tons hence the deficit estimated at 112,000 tons (BAMB, 2012). Therefore, Botswana imports about 90 percent of maize to augment local production and therefore, to meet the national demand of maize.

The international prices of most food commodities increased sharply between year 2005 and 2008. Ivanic and Martin (2008) reported that while the prices of cereals such as wheat rose by 70 percent and rice by about 25 percent between 2005 and 2007, the world maize prices increased by 80 percent. This increase in prices of food grains was attributed to a number of factors which included; rising incomes in India and China contributing to an increasein global demand for food; rising petroleum prices; increased demand for bio-fuel feedstock from corn and rapeseed; currency fluctuation among others (Grynberg and Motswapong, 2009). Rising food prices provide an opportunity to farmers in Africa to raise their income depending on the market structures, magnitude of commodity price increase relative to input costs and whether farmers are net buyers or net sellers of food (Ackello-Ogutu, 2011).

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However, the extent to which the increase in prices of cereals in the international market has been transmitted to domestic economies in recent years has been a key issue. The extent of price transmission is important for at least two reasons. Domestic prices affect the welfare of poor consumers and farmers. Second, the magnitude of price transmission helps in determining the extent to which adjustments by producers and consumers will stabilize world price changes (Keats et al., 2010).

Most net agricultural produce importing countries in the world faced balance-of-payment pressure due to the price shocks as the cost of food imports rose (Minot, 2011). This worsened foreign exchange constraints as well as directly affecting food security. Being an importing country, Botswana was also affected by the worldwide impact of global food price rise. The global price rise had devastating implications on the general economy of Botswana (BIDPA, 2008). Firstly, income parity increased due to reduced purchasing power of consumers caused by rising food prices (Minot, 2011). Consequently, poor people who have limited employment opportunities and spent a higher proportion of their income on food and leaving less spending on other items. Botswana also experienced a rise in government expenditure as the government provides a number of food-based social safety programmes to the poor and vulnerable segments of the society (Tlhalefang and Galebotswe, 2013). Consequently, the country faced with an increasing import bill because of increased food prices in the international markets. All these pressurised on the already declining foreign exchange reserves in the country.

Studies have been conducted on the implications of the high prices from the global price rise on the local market of many countries. Generally, these studies analysed the impacts of these price spikes on the domestic economy (Hossain and Green, 2011). Grain trade in Botswana is dominated by Botswana Agricultural Marketing Board (BAMB), a state trading agency that acts as a market price setter. There is lack of evidence on the transmission of prices from South Africa to Botswana in the maize market. An understanding of commodity price relationships and transmissions between the two neighbouring markets becomes necessary since Botswana imports maize mainly from South Africa. Therefore, there was a need to study and analyse the maize price transmission into Botswana. The findings of the study should provide valuable information to policy makers and analysts as well as traders, by availing information on the maize price transmission changing aspects in Botswana to help in guiding trade policy to come up with effective pricing policies ensuring price stabilization.

The purpose of this study was to evaluate the transmission of South African maize prices into Botswana markets. The specific objectives of this study were:

i. To determine the integration of maize markets in Botswana and South Africa.
ii. To evaluate the transmission of South Africanmaize prices into the Botswana markets.

The research hypothesis of the study was that there is no cointegration of maize price between Botswana and South African markets

LITERATURE REVIEW

Price transmission analysis measures the effect of prices in one market on the prices in another market. Price transmission refers to the co-movement shown by prices of the same good in markets at different locations (Listorti, 2008). It is measured in terms of the transmission elasticity which is defined as the percentage change in the price in one market given a one percent change in the price in another market (Minot, 2011). Price Transmission can be either vertical or horizontal (spatial).Vertical price transmission is the degree of adjustment and speed with which price changes are transmitted between producers, wholesalers, and retail markets which is indicative of actions of market participants along the market channel (Supply chain) (Abdulai, 2000). In other words, vertical price transmission refers to interactions between prices at different supply chain stages (Vavra and Goodwin, 2005). Horizontal or Spatial price transmission refers to the relationship in prices among spatially separated markets within a country, or how domestic prices adjust to international prices (Abdulai, 2000).

Price transmission analysis is based on the Law of One Price (LOP) which follows the spatial arbitrage condition that: the price of a homogeneous commodity at any two different locations will differ by the cost of moving the goods from the region of lower price to the region with higher price (Fackler and Goodwin, 2002). Price transmission is usually incomplete and the reasons for that are various (Conforti, 2004). Excessive transaction costs (e.g. transport costs, incomplete information, search for information, negotiation costs, costs associated with supervision and application of contracts). Whenever transaction costs are disproportionate, the benefits of spatial arbitrage disappear and the LOP cannot hold anymore. Border policies (such as tariffs and non-tariff barriers, import quotas, export subsidies): By restraining international trade, border policies cut the price transmission channel from international to domestic markets. Domestic policies such as price intervention, minimum price, marketing board impede price transmission along the marketing chain within the country.

Several authors have studied price transmission within the context of the Law of One Price or within the context of market integration. Abidoye and Labuschagne (2013) evaluated the co-movement and transmission of world prices to domestic prices in sub-Sahara African countries. The study compared nested and non-nested models that capture different forms of nonlinearity in the price spread. A Bayesian approach that allows for comparison of models using Bayes factor was adopted in this study and it was reported that threshold effects exist, such that small changes in world prices are not transmitted to domestic South African maize markets. The study also concluded that large long-run deviations in price are transmitted and found that about 98 percent of the variation in world prices is eventually transmitted to the maize price in South Africa.

Nzuma (2013) undertook a study evaluating the food price crisis and the accompanying food policy interventions in Kenya using a political economy approach. The study used both qualitative and quantitative data to evaluate the political economy of the food price crisis in Kenya. The qualitative data on food policy interventions was used to examine the political economy of food policies in Kenya, while the quantitative data on food prices was used to explore the transmission of international prices into domestic markets. The study used a VECM and found that about 30 per cent of the changes in world market prices are transmitted to domestic markets in Kenya. A relatively slow speed of adjustment of domestic food prices in Kenya of between three to five months was found to their long-run relationship with international prices.

Acosta (2012) assessed the spatial transmission of white maize prices between South Africa and Mozambique using an asymmetric error correction model (ECM). The study found that the transmission of white maize prices from South Africa to Mozambique was co- integrated in the long run but not co-integrated in the short run. The transmission of these prices was asymmetric depending on whether the international price increased or decreased. It was suggested that some of the barriers that constrain a more efficient price transmission were related to the presence of a highly prohibitive import tariff and the structure of a value added tax.

Ankamah-Yeboah (2012) assessed price transmission of maize market in Ghana. The study used regional monthly wholesale price data from 2002 – 2010 and employed the threshold autoregressive model. Bidirectional market interdependence was found between market pairs both in the short and long run. The long-run causality was however heterogeneous with respect to positive and negative shocks. Price adjustment was found to be asymmetric with traders respond quickly when market margins are squeezed than when stretched for all market pairs. The time path needed for adjustment ranged from 7 to 26 months.

Kaspersen and Foyn (2010) evaluated price transmission for different agricultural commodities between world markets and the Ugandan market. The study used a Vector Autoregressive (VAR) Model that used weekly market prices for sorghum from 1999 to 2008 and monthly producer prices from January 1977 through April 2006 for Robusta coffee. The results indicated that sorghum price in Uganda were not integrated with world markets while oil prices were found to be determining factor for sorghum price transmission within the country. Robusta coffee, prices in Uganda were found to be strongly connected to world prices, and did not depend on the oil price.

Minot (2009) studied the transmission of world food price changes to African markets and its effect on household welfare. Relationship between world food prices and domestic food prices in nine African countries: Ethiopia, Ghana, Kenya, Malawi, Mozambique, South Africa, Tanzania, Uganda and Zambia over five years were inferred using a vector error-correction model. The data consisted of 62 domestic price series for maize, rice, and wheat. Only 13 of the 62 price series showed a long-run relationship in which the domestic price is influenced by the international price of the same commodity. Indeed, of these 13 domestic prices that showed a long-run relationship with international prices, only six have a long-term elasticity of transmission that was statistically significant.

Kilima (2006) assessed the extent to which world market price changes were transmitted into local producer prices for four agricultural product markets in Tanzania: sugar, cotton, wheat and rice for the period between 1994 and 2005. The study used co-integration and causality techniques to test for price linkages. The study found imperfect transmission between prices in Tanzania and the world market prices. However, Granger-causality tests revealed the existence of a unidirectional causal relationship, whereby commodity prices in the world market caused prices changes in Tanzania. These results reflected that although commodity prices in the world market and local markets in Tanzania drifted apart, but some shocks from the world market passed through to Tanzania.

METHODOLOGY

Theoretical Framework

Price transmission analysis has been widely used in the context of the 'Law of One Price' (LOP). An increase in the international price will lead to an equal increase in the domestic price, at all points in time proportionally, assuming the markets are perfectly integrated (Rapsomanikis *et al*., 2006).Various methods have been developed to test for price transmission analysis namely the simple bivariate correlation coefficients; the Ravallion (1986) method; Engle–Granger procedure (1987) and cointegration methods. The commonly used method for this type of study is the Error Correction Model (ECM). The Vector Error Correction Model (VECM) is an extension of co-integration techniques and is intuitively appealing for the study to analyse price transmission, since it allows separating short and long-run market dynamics (Conforti, 2004).

In testing for price transmission, a number of time series techniques are used to test the components of price transmission. According to Rapsomanikis et al. (2006), these components are i) completeness of adjustment which implies that changes in prices in one market are fully transmitted to the other at all points of time; ii) dynamics and speed of adjustment which implies the process by, and rate at which, changes in prices in one market are filtered to the other market or levels; and, iii) asymmetry of response which implies that upward and downward movements in the price in one market are symmetrically or asymmetrically transmitted to the other. Both the extent of completeness and the speed of the adjustment can be asymmetric.

The analysis of price transmission proceeds in three stages that include tests for stationarity, test for cointegration, and the estimation of an error correction model. Stationarity is defined as a quality of a process in which the statistical parameters (mean and standard deviation) of the process do not change with time (Vavra and Goodwin, 2005). It follows that non-stationary time series or stochastic process evolves over time. It may have trends in its mean or variance. Many economic time series are non-stationary, and some transformation such as differencing or de-trending is typically needed to make them stationary.

In the presence of non-stationary variables, there might be what Granger and Newbold (1974) call a spurious regression. A spurious regression appears to have significant relationship among variables but the results are in fact without any economic meaning. If a time series is differenced once (by subtracting yt-1 from yt) and the differenced series is stationary, the series is then “integrated of order 1”, denoted by I(1). In general, if a time series has to be differenced "d" times to be stationary; it is referred to as I(d). By convention, if d= 0, I(0) process represents a stationary time series.Stationarity of a series is an important phenomenon because it can influence its behaviour. Stationarity test that has become more widely popular for the past years is the unit root test.

Cointegration test is concerned with estimating long-run economic relationships among nonstationary and integrated variables. Variables are said to be co-integrated when they share a common unit root and the sequence of stochastic shocks is common for both. If two non-stationary series are cointegrated then, by definition, the extent by which they diverge from each other will have stationary characteristics and will reflect only the disequilibrium. Thus cointegration is a powerful concept that allows capturing the equilibrium relationship even between non-stationary series (if such equilibrium relationship exists) within a stationary model (Vavra and Goodwin, 2005). If the series indicate that the series are cointegrated, then one can test for transmission of prices.

The framework in Figure 1 was adopted for testing the price transmission however; the current study focused on two countries and did not perform the test for Granger causality.

Empirical Models

Testing for Unit roots

A variable is said to contain a unit root if it is non stationary (Vavra and Goodwin, 2005). A time series that has a unit root is known as a random walk. Vavra and Goodwin (2005) defined a random walk as a process where the current value of a variable is composed of the past value plus an error term defined as a white noise. White noise refers to a normal variable that is uncorrelated with past values and has a mean of zero. The implication of a random walk process is that the best prediction of a variable *y* for next period is the current value, or in other words the process does not allow to predict the change in the variable from the previous period ($y_t - y_{t-1}$). That is, the change of *y* is absolutely random. The mean of a random walk process is constant but its variance is not. As time increases the variance of y_t approaches to infinity. Thus the terms nonstationarity, random walk, and unit root can be treated as synonymous.

A variable is said to contain a unit root or is I(1) if it is non-stationary. The use of data characterised by unit roots may lead to serious error in statistical inference. According to Vavra and Goodwin (2005):

$$y_t = \beta y_{t-1} + \varepsilon_t \text{......................................(3.1)}$$

If equation (3.1) equals one, the model is said to be characterised by unit root (the equation becomes the random walk model), and the series is non-stationary (Vavra and Goodwin, 2005). For a series to be stationary, must be less than unity in absolute value. Hence stationarity requires that $-1 < \beta < 1$.The purpose of the unit root test is to determine whether the series is consistent with I(1) (integrated of order one) process with a stochastic trend, (Nelson and Plosser, 1982 and Juselius, 1993). The commonly used tests for the presence of unit roots are the t-like tests proposed by Dickey and Fuller (1979) and the alternative test proposed by Phillips and Perron (1988).

Cointegration Test

If the unit root test on the data reveals that all variables are difference-stationary then a precondition for the existence of a stable steady-state relationship in the system is cointegration among the variables. A vector of variables is said to be cointegrated if each variable in the vector has a unit in its univariate representation, but some linear combination of these variables is stationary (Engle and Granger 1987). The main purpose of cointegration analysis is to test whether any two non-stationary time series have a long run relationship. There are two possible procedures that can be applied on price series to test for cointegration namely the

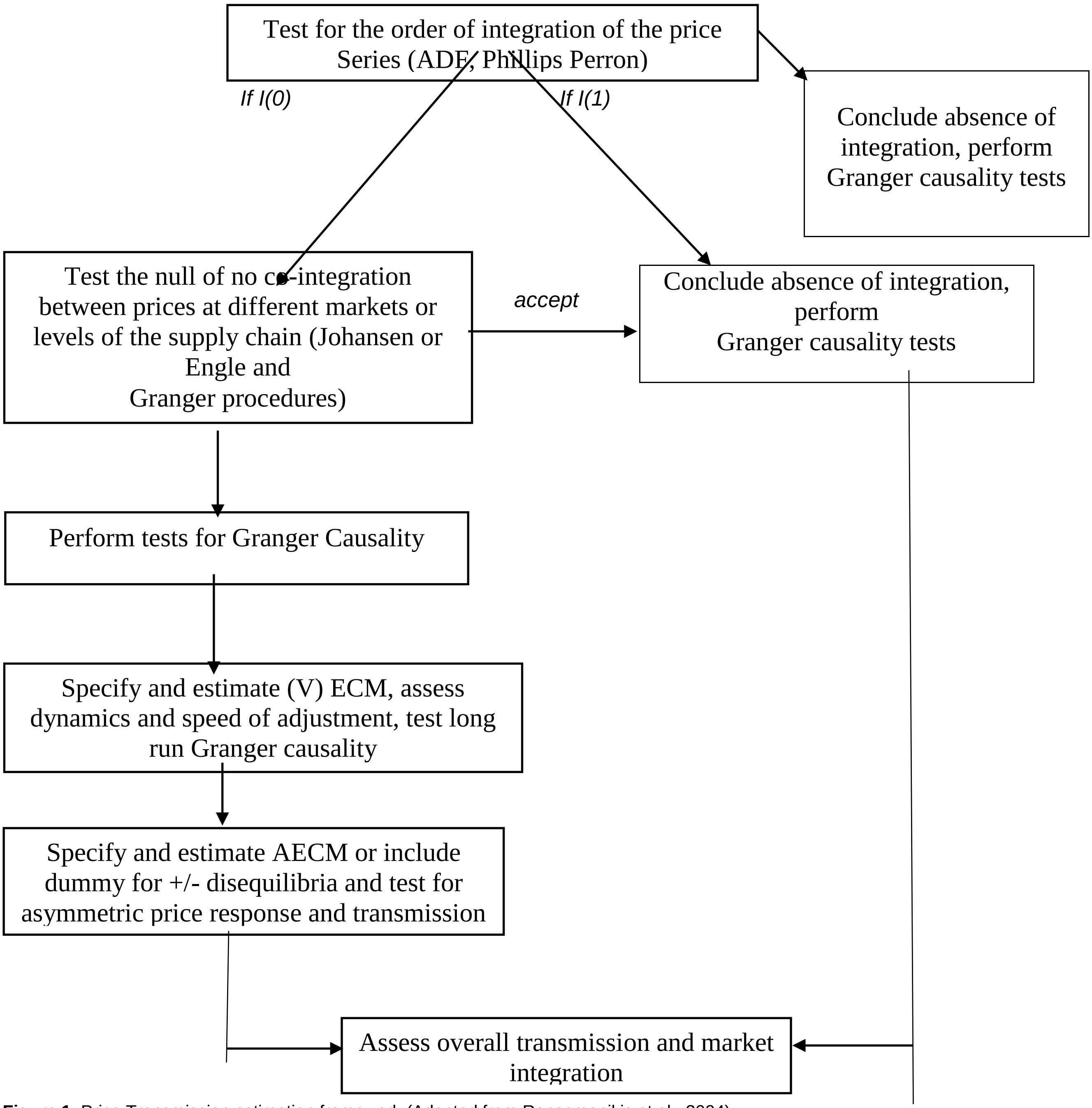

Figure 1. Price Transmission estimation framework (Adopted from Rapsomanikis et al., 2004)

Granger and Engle cointegration test and, the Johansen cointegration test. The study adopted the Johansen cointegration test.

According to Hjalmarsson and Österholm, (2010), the standard approach to the Johansen maximum likelihood (JML) procedure is to first calculate the Trace test statistic and Maximum Eigenvalue statistics, then compare these to the appropriate critical values. Hjalmarsson and Österholm (2010), specified these tests as follows;

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln\,(1 - \hat{\lambda}_i \ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

$$J_{max} = -T \ln\left(1 - \hat{\lambda}_{r+1}\right) \ldots\ldots\ldots\ldots\ldots \quad (3.3)$$

Where T is the sample size and $\hat{\lambda}_i$ is the *i*th largest canonical correlation.

The trace test tests the null hypothesis of *r*cointegrating vectors against the alternative hypothesis of *n*cointegrating vectors. On the other hand, he maximum eigenvalue test, tests the null hypothesis of *r*cointegrating vectors against the alternative hypothesis of r+1cointegrating vectors (Hjalmarsson and Österholm, 2010). For both tests, if the statistic is bigger than the critical value, the null hypothesis of at most *r*cointegrating vectors is rejected. The procedure tests the sequence of hypotheses of *r*cointegrating vectors up to $r \leq n$-1.

Price Transmission Analysis

Price transmission is a measure of the effects of price changes in one market on prices in another market (Minot, 2011). Upon establishing the existence of long-run relationship between price variables, then price

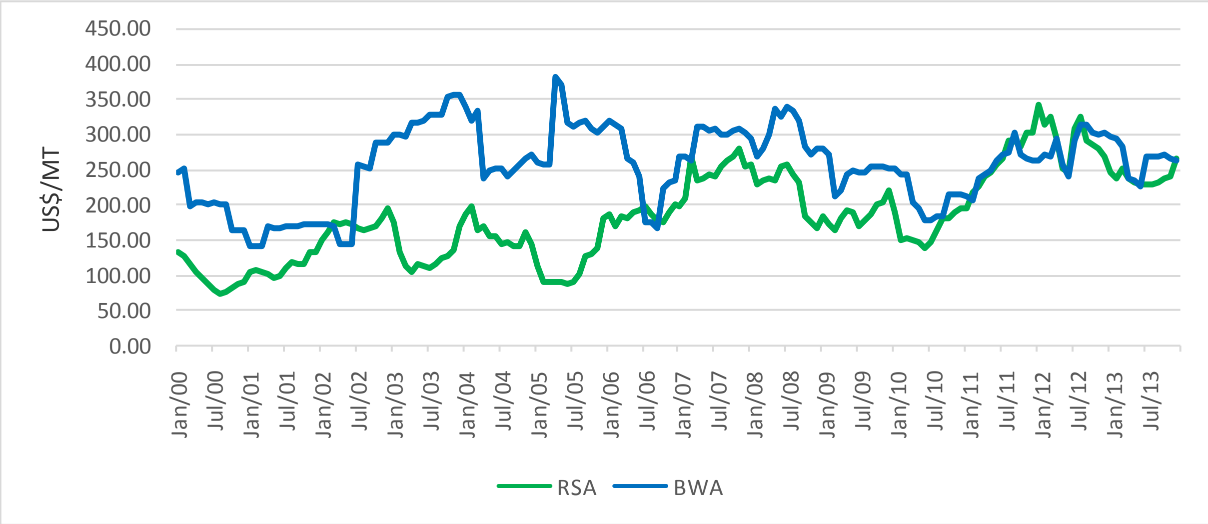

Figure 2. Nominal maize price trends 2000 to 2013

transmission can be estimated to find the elasticity of transmission, and the speed of adjustment of domestic prices towards equilibrium following a change in price in the international price.

Following Minots' (2011) methodology of price transmission measure, the study only concentrates in one portion of the VECM which deals with transmission of world market prices into the domestic market because Botswana is considered a small country i.e., the country is a price taker in the international market therefore its actions have no effect on the international commodity prices. Minot (2011) specified the model is specified as follows.

$$\Delta p_t^d = \alpha + \theta\left(p_{t-1}^d - \beta p_{t-1}^w\right) + \delta \Delta p_{t-1}^w + \rho \Delta p_{t-1}^d \ldots\ldots (3.4)$$

Where:

p_t^d is the log of domestic price (Botswana price) converted to US dollars (endogenous variable).
p_t^w is the log of South African price of maize in US dollars (exogenous variable)
Δ is the difference operator, so $\Delta p_t = p_t - p_{t-1}$
α, θ, β, δ, and ρ are parameters to be estimated, and
ε_t is the error term

Data Collection

The monthly wholesale maize price series over the period 2000 to 2013 were collected from Botswana and South Africa. The Gaborone price series was used as an indicator of the domestic market while Gauteng price series was used as an indicator of South African market.

Monthly wholesale maize price data for Botswana was obtained from the Botswana Agricultural Marketing Board (BAMB) and, the Central Statistics Office (CSO). For South Africa, the study utilised maize wholesale data reported by the Agricultural Market Division of the South African Futures Exchange (SAFEX) obtained from FAO GIEWS Food Price Data Analysis Tool website (http://www.fao.org/giews/pricetool/).

RESULTS AND DISCUSSION

The results of the study are presented in the sections as follows.

Trends in Domestic and International Nominal Prices of Maize

It was considered important to present the trends in maize prices nationally and internationally so as to understand the maize price scenario over a period of time.
Figure 2 presents the trends in monthly nominal maize prices for the 2000-2013 periods in South Africa and Botswana.

The Botswana maize prices (BWA) are relatively higher than the South African (RSA) market prices over the 2000-2013 periods (Figure 2). The trend shows that Botswana prices were higher than the South African maize prices from 2003 to 2006 reaching the highest price of $309.50 when South Africa recorded a lower price of $94.36 around the same time. This may be because the government of Botswana introduced new border measures where grain importers (processors) are to purchase a given proportion of their supplies requirements from domestic sources, of which Botswana Agricultural Marketing Board (BAMB) is the principal player, before they could be issued import permits for the remainder. Maize domestic procurement requirements were set at 60 percent (Republic of Botswana, 2005).

The trends in Botswana maize prices over the 2000-2013 period remained volatile which is indication of data stationarity. However, these cannot be used to

Table 1. Unit Root Tests (ADF & PP) Results for Maize Prices

Series	Level			First Difference		I(d)
	ADF	PP	Lags	ADF	PP	
Logarithms of maize wholesale prices						
Botswana	-2.87	-2.94	1	-12.92	-12.92	I(1)
South Africa	-3.16	-3.19	1	-9.46	-9.44	I(1)
5% Critical Values	-3.44	-3.44		-3.44	-3.44	

Table 2. Johansen's Maximum Eigen value and trace test statistic for the number of cointegrating vectors in Botswana and South Africa markets (2000 - 2013)

Hypothesized No. of CE(s)	Trace Statistic	Trace 0.05 Critical Value	λmax Statistic	λmax 0.05 Critical Value**
r=0*	19.53	15.49	16.01	14.26
r≤1	3.51	3.84	3.51	3.84

**The critical values are obtained using Osterwald-Lenum.
* denotes rejection of the hypothesis of no cointegration at the 0.05 level.

formally confirm the existence of data nonstationarity which is tested in the preceding section. In overall assessment of the trends, prices indicate that maize prices in Botswana and South Africa are comparable to the international reference price.

Unit Root Tests

The results of Augmented Dickey Fuller (ADF) and Phillip-Perron (PP) tests in levels and first difference are presented in Table 1 presented. The ADF test was performed including the up to 13 lagged terms of the differenced terms in the regression. Akaike Information Criterion (AIC) was used to choose the appropriate lag length.

The ADF and PP test results suggest that price series estimated in levels are non-stationary while those estimated in first differences are stationary I(1). These results imply that the mean and standard deviations of Botswana price series do not vary with time. Given that the price series were I(1), the Johansen Maximum Likelihood (JML) procedure was then used to determine whether a stable long-run relationship exists between the variables.

Co-integration Analysis (Johansen Maximum Likelihood)

Table 2 presents the results for the Johansen Maximum Likelihood estimates for the cointegration test. The results of the cointegration analysis indicated that the hypothesis of no cointegration between South Africa and Botswana maize prices is rejected at the five percent significance level (Table 2). However, the null hypothesis of having at most one co-integrating relationship between the South African and Botswana maize prices cannot be rejected at the five percent level of significance.

The results reflected that trace statistic and max-eigenvalue statistic are significant at .05 significance level for both the tests. Therefore the null hypothesis of having one cointegration relationship cannot be

Table 3. Vector Error Correction Model for Botswana and South African Maize Prices (2000 - 2013)

	Long-run adjustment β	Speed of adjustment θ	Short-run adjustment δ	R^2
BWA-RSA	0.861 (-4.98)	-0.074 (-3.00)	0.161 (1.85)	10.51

The figures in parentheses are the t-statistic.

rejected. Both the trace test statistic and max-eigenvalue test statistic suggest the presence of one cointegrating relationship which can be interpreted as an estimate for a long-run cointegrating relationship between the South African and Botswana maize market prices. Therefore, it can be concluded that Botswana and South African maize markets are well linked.

The presence of cointegration between Botswana and South Africa markets was expected as Botswana's maize imports come from South Africa. This leads to the conclusion that there is continuous trade of maize between Botswana and South Africa hence, the tendency of the price series to establish a long-run relationship.The findings of this study are supported by findings from other studies in the Sub Saharan African region (Myers and Jayne, 2012; Rapsomanikis, 2009) which determined that the maize markets in the countries in the region and South Africa exhibit a fairly high level of price transmission. Therefore, the findings for the estimation of a vector error correction model (VECM) for the Botswana and South African maize markets are important.

Transmission of South African Maize Prices into Botswana Market

Since Botswana maize prices are co-integrated with South African maize prices, a vector error correction model (VECM) is estimated in an attempt to test for the evidence of the transmission of price signals from South African market into the Botswana market. The Vector Error Correction Model (VECM) results indicated that maize prices from South Africa are transmitted to Botswana domestic market in the long-run, but not in the short run. The elasticity of price transmission from South Africa into Botswana was estimated at 0.86 (Table 3). This suggests that 86 percent of maize price changes in the South African market prices are transmitted to the Botswana market in the long-run hence high integration almost close to unitary elasticity. This high elasticity of price transmission may be an indication that trade policy is effective in reducing volatility and that the markets are functioning efficiently as they are closer together it is expected for the elasticity to be close to unitary elasticity. The high price transmission is consistent with expectation that when two markets share boarder, the prices of the same commodity are the same only differing by the transfer costs hence, the law of one price (LOP) exited.

The elasticity of price transmission is high but this was expected given that Botswana is a net maize importer and about 90% of the maize imports are sourced from South Africa. This can be attributed to the government of Botswana's grain trade policy through the agricultural marketing board. (BAMB). The government sets minimum prices to producers and a maximum wholesale prices which maybe an impediment to full price transmission. However, because BAMB refers to South African Futures Exchange (SAFEX) prices to determine the domestic prices, price transmission should be existent to a certain level. For the maize market, price transmission has been found to be quite high at 86 percent from the South African market into the domestic market. This can reflect the fact that maize production has been low in the country with a higher consumption hence increasing imports.

The short-run coefficient (δ) is not significant, which suggests that, in the short-run, changes in the South African prices do not have any significant influence on the Botswana domestic prices. The speed of adjustment (θ) to the long-run relationship coefficient was estimated at -0.074 (Table 4.3). This coefficient is negative and significant which means that the prices in the domestic market adjust to disequilibrium towards the long-run equilibrium state. The coefficient indicates that the time it takes for white maize prices in Botswana to return to an equilibrium after a change in the South African white maize price is about 13 months.

The speed of adjustment is found to be very slow yet the elasticity of price transmission is high and the two countries share a boarder. The slow speed of adjustment implies that the Botswana maize prices take a long time to get back the equilibrium price when there is a price change signal from the South African maize market price. This may be due to underdeveloped infrastructure between the two markets. Grain imports from South Africa into Botswana are transported through roads which may be poor and hence delaying the delivery process of the maize. Benson et al. (2008) argued that the changes in food prices in Sub Saharan Africa could be better explained by domestic factors rather than by changes in the world food prices.

Factors such as transportation and communication costs may be high due to poor infrastructure such as roads and storage facilities. Most of the commercial silos and warehouses in Botswana are owned by BAMB therefore who manage the stock therefore lack of these facilities for private millers may also add to the slow speed of adjustment. Another reason that may impede a fast adjustment of prices to equilibrium maybe the fluctuating domestic supply due to unreliable rain fed arable production. This may lead the government to making mistakes of falsely estimating the expected supply and thus not acting quickly enough when problems of grain shortage arise therefore leading to a prolonged return to equilibrium.

The time it takes for domestic maize prices to return to long-run equilibrium state may also be explained by the measures taken by the government of Botswana with the purpose of lessening the problem of food security in the country.Following a price change in South African market, the Botswana government may introduce measures to reduce the impacts to be on the local markets which may also affect local price transmission and speed of adjustment to international price changes. For example, the introduction of boarder measures where processors and other grain importers are required to purchase a given proportion of their supplies requirements from domestic sources before they can be issued import permits for the remainder. Maize domestic procurement requirements are set at 60 percent. This may cause domestic prices to adjust less rapidly to disequilibrium towards the long-run equilibrium state. Therefore, the results of this study show that there exists long-term relationship between Botswana and South African maize markets but not in the short-run.

CONCLUSION AND RECOMMENDATIONS

The study analysed the price transmission of maize market in Botswana following a price change in South African market. The elasticity of transmission was 86 percent which reflected high transmission of price signals from the South African maize market into the domestic market. It was therefore concluded that the two markets have a steady relationship and the markets are functioning effectively. However, this finding has a policy implication that the South African maize market has a significant effect on the Botswana market hence the country almost having total dependence on maize as a staple food through imports. Therefore, it was recommended to promote production of other staple food grains such as sorghum to avoid food insecurity especially when maize price increases in the South African markets.

The speed of adjustment of the Botswana prices to long-run equilibrium was found to be very slow as it takesabout 13 months for the changes in South African maize market prices to be reflected in the Botswana market. The regulating of grain prices by government through BAMB can therefore be concluded as an impediment of effective transmission of prices. Therefore, it was recommended that the involvement of BAMB in grain tradeshould be minimised. This can be realised by reduction of the maize domestic procurement requirements to lesser than the current rate of 60 percent.

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