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Measuring the impact of Swaziland's import licensing and price-setting policy on price dynamics between South African and Swaziland maize markets

by

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I declare that the dissertation that I hereby submit for the degree in Agricultural Economics at the University of Pretoria has not previous been submitted by me for degree purposes at any other university.

SIGNATURE:………..………………….. DATE: ………………………………

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Abstract

In Swaziland, maize is important for food security, yet its production is low and the country has not achieved self-sufficiency. Swaziland has had a shortfall in domestic maize production since independence. About 80 percent of the rural population never has enough maize for consumption. The National Maize Corporation (NMC) was established as a self-sufficiency mechanism in 1985. The NMC is the only white maize importer and is also responsible for the stabilisation of domestic prices. The organisation has endeavoured to stabilise Swaziland's maize prices, though they are still high by regional comparisons.

This study seeks to investigate the relationship between Swaziland and South African white maize prices in the presence of maize marketing and pricing policy, as implemented by the NMC. The maize marketing policy controls flow of maize imports and exports in Swaziland, while the pricing policy controls the domestic white maize prices. The current pricing relationship between the two countries was compared with a scenario where marketing and pricing policies in Swaziland are absent. This was done in order to gauge the effect that these policies have on the integration of Swaziland into the regional maize market and ultimately how Swaziland maize prices are affected by price transmission process in the presence and absence of these policies. The study used secondary data from the NMC, the Ministry of Agriculture, and journals. Monthly data from 2000 to 2014 are used and econometric time series techniques are applied.

The study hypothesised that there is a long-run relationship between Swaziland and South African maize prices, given the current market structure. It also hypothesised the short-run dynamics correct deviations from the long run in a fast and efficient manner. Lastly, it is hypothesised that current policies are not hampering marketing integration or impeding regional price signals to flow through to Swaziland maize markets.

The results confirm the presence of a long-run price relationship between the above-mentioned markets. In the presence of the current maize marketing and pricing policy, the error correction term corrected or adjusted the disequilibrium, from long-run equilibrium levels, at a speed of 3.8 per cent per period, indicating relatively slow correction. This could serve as evidence of inefficient integration between the two markets and an indication of weak arbitrage process. Weak arbitrage, in turn, has definite welfare implications in that it leads to inefficient allocation of resources. In comparison to the other scenario, there is a slight difference: when analysing the relationship between import parity and Swaziland domestic prices without policy measures, short-run and long-run relationship between markets are also confirmed. Here the error correction term, however corrected the disequilibrium of the system at a speed of 4.7 percent per period. This shows a slight improvement of efficiency when policies are eliminated.

This study could be useful to policy makers in that it imparts knowledge on how world price signals are transmitted to their domestic markets. Understanding the price dynamics could, therefore, facilitate policy formulation related to price and marketing in the white maize industry. The findings of this study could ultimately also inform the self-sufficiency versus food affordability debate.

Keywords: market integration, white maize prices, government policies, South Africa, Swaziland

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Acronyms

ADF	Augmented Dickey-Fuller test
AECM	Asymmetric error correction model
AIC	Akaike Information Criteria
ECM	Error correction model
FAO	Food Agricultural Organisation
FANRPAN	Food and Agricultural and Natural Resources Policy Analysis Network
GC	Granger Causality
JADAFA	Joint Agribusiness Department of Agriculture, Forestry and Fisheries Forum For Africa
LOOP	Law of one price
NAMBOARD	National Agricultural Marketing Board
NMC	National Maize Corporation
TAR	Threshold Autoregressive
TDL	Title Deed Land
SAFEX	South African Futures Exchange
SIC	Schwarz information criterion
SNAU	Swaziland National Agricultural Union
SNL	Swazi Nation Land
TECM	Threshold Error Correction Model
VAC	Vulnerability Assessment Committee
WFP	World Food Programme

Chapter One

1.1 Introduction

Swaziland's staple crop is white maize. White maize production constitutes more than 95 percent of the country's entire cereal production (Mano et al., 2003). The crop is cultivated in both the customary Title Deed Land (TDL) and Swazi Nation Land (SNL) (Sithole & Apedaile, 1987; Dlamini & Masuku, 2011). It is further stated that on the TDL, white maize farming uses full management practices, such as irrigation, and are as a result, market oriented. The TDL covers an area of 60 percent of the of the total land area (Magagula, Dlamini & Mkhwanazi, 2007). In 2011 the average maize yield per hectare on the Swazi Nation Land is 4.42 tons, whereas the Title Deed Land has an average of yield of 9.75 tons (Dlamini & Masuku, 2011).

Maize consumption contributes 60 percent of total dietary requirements of the Swazi population. Therefore, maize is important for food security and Swazi's on average consume 166 794 tonnes. This is the lowest quantity consumed compared to countries in the region such as South Africa, Zambia, and Lesotho with 9 599 427 tonnes,1548462 tonnes and 369 193 tonnes, respectively [FAO/Bioenergy and Food security projects (BEFS), 2013]. Swaziland is, however, not self-sufficient in maize production and, as a result, is a net importer of white maize. The low maize production in Swaziland is reflective of the current food situation, that the country is food insecure (Magagula & Faki, 1999). About 80 percent of the rural population do not have enough maize for them to meet their consumption requirement (Joint Agribusiness Department of Agriculture, Forestry and Fisheries Forum for Africa, 'JADAFA', 2014). Swaziland has had shortfalls in domestic production of maize since 1985 (Mashinini et al., 2006). According to the Vulnerability Assessment Committee (VAC, 2012), in the year 2012, there was a 34 percent shortfall in maize production in Swaziland. More recent figures suggest that Swaziland has a 24 percent deficit (NMC, 2014).

The deficit in maize production is caused by poor management practices, dependence on rainfall for production, inadequate access to finance, and poor storage facilities (FANRPAN, 2003). Most small-scale white maize farmers have temporary storage maize cribs which they construct almost every year (Swaziland National Agricultural Union, 'SNAU', 2010). These poor maize storage facilities result in significant white maize post-harvest losses. Extreme losses are noticeable in periods of droughts and floods (Ndlela & Mkhabela, 2008). It is further stated that Swazi white maize yields reflect the variability of the unpredictable weather conditions. The lack of extension services and input supplies also contribute low maize production (SNAU, 2010). Most farmers produce not more than 40 bags of 50 kg per hectare (SNAU, 2010). To curb these problems, the government intervened to assist farmers in the improvement of management practices.

The government formulated the self-sufficiency policy in the 1980s for maize, which are managed through three channels: local price setting, maize marketing policies, and other programmes, which included input support etc. (Magagula & Faki, 1999). The self-sufficiency policy's main objective was to reduce the problem of maize deficiency in the country. The Input Support Programme, which subsidises basic inputs such as seed and fertiliser, was implemented in order to improve maize production, with the ultimate objective of attaining food security and self-sufficiency (SNAU, 2010). The price setting policy allows government control through the annual setting of selling and buying prices of white maize. The prices are derived from import parity (National Maize Corporation, 'NMC', 2005) through a formula that will be elaborated on in Chapter Three. The price setting and the maize marketing policy are implemented by the National Maize Corporation (NMC, 2010).

The establishment of the NMC was to ensure higher local maize production, thereby achieving higher levels of self-sufficiency and reduction of reliance on imports through the subsidising of producer prices as one of the motives. The corporation has the sole legal right to import commercial white maize into the country, therefore exerting a sort of an import quota. It is also responsible for the stabilisation of white maize prices. However, Swazi local maize prices are still high, compared with other countries in the Southern African region (UNCOMTRADE, 2015). These policies all influence the price determination and transmission process in Swaziland. According to Meyer (2006), a country's specific trade and policy regimes determine the dynamics of price formation, and the integration of these prices with world prices. Anything that happens to international markets could be transmitted into the domestic market. For small countries (in terms of production volumes), world prices can be assumed exogenous, and transmitted to domestic prices if policy and market structures are conducive for it.

This leads to the question of how conducive domestic policies in Swaziland are for international white maize prices to flow through to regional prices and whether the Swazi market is integrated regionally. It is important to know whether Swaziland is integrated regionally, because an integrated market with efficient price transmission supports the effective allocation of resources. This, in turn, touches on issues related to the self-sufficiency versus food affordability debate, which is common in various developing countries.

Marketing and pricing policies can be responsible for poor, or the absence of, market integration. Conforti (2004) highlights the point that the presence of government policies affects trade and may impact on the integration of international and domestic markets. Huang et al. (2009) echoes this by noting that the removal of domestic policy restrictions increases the extent of price transmission between domestic and international prices and further states that these policies can insulate domestic markets through the obstruction of price signals from world markets. Poor market integration caused by government policies results in less information on prices being available to economic agents, subsequently causing decisions that support inefficient outcomes (Rapsomanikis et al, 2004). Poor market integration therefore has clear implications for welfare of different economic agents but also in more general terms. Indicators based on market efficiency and integration analysis could therefore be important for directing the focus of policies towards improving welfare.

It is clear that commodity pricing and marketing policy, particularly in staple foods, can promote food availability and affordability. However, the setting of high maize prices in pursuit of maize self-sufficiency does not necessarily contribute to income growth, thus affecting consumer welfare (Jayne & Rukuni, 1993).

1.2 Problem statement

1.2.1 General Problem Statement

Swaziland produces less white maize than meets its consumption requirements, yet there is room to increase production through input subsidies, improved storage and increased domestic prices. The high domestic white maize prices however burdens consumers with the incidence of inducing a positive supply response (Sukati, 2013) and is subsequently disturbing the nation's consumption patterns. In order to contextualise the high prices referred to above it is noteworthy that local maize prices are higher in Swaziland compared to South Africa's, with which it shares a border. In 2010 the South African white maize spot price was R1201.62 per ton (South African Grain Information Service, 'SAGIS', 2015), while Swaziland's domestic price stood at R2177.50 per ton (NMC, 2014). Recently, in 2014, South African spot prices were R2303.17 per ton and Swaziland's domestic price was R3375.00 per ton (NMC, 2014).

Changes in policies, institutions, and technology, among other factors impact on commodity price formation (De Haen, 2002). Agricultural commodity markets in Africa have been characterised by a high degree of government interventions, which include policies and institutions that affect agricultural production (Listorti, 2009) and ultimately prices. In Swaziland, policies as mentioned earlier may have negative impact on the white maize supply chain. As mentioned above, the pricing policy, gives benefits to the producers, while taxing consumers. Increased producer prices lead to ripple effects, such as higher wholesale and consumer prices (Jayne & Rukuni, 1993).

In the case of Swaziland, a net importer of white maize grain, the domestic market, could be considered vulnerable to price instability in world markets. In the case of market integration, an improvement would result in winners and losers. Improved market integration could result in lower prices for consumers, but would ultimately come at a cost of sacrificing production feasibility for some producers, with current policies trying to establish an environment that is enabling for producers. Therefore, it is of interest to the researcher to ascertain the effect that government policies have in the transmission of prices between South Africa (which serves as a proxy for world markets) and Swaziland.

Understanding how price shocks are transmitted between different countries, and how such transmission has been affected, with or without, government policies, is necessary for policy analysis and future policy decisions. It is important that policy makers and other stake holders, such as marketing boards, retailers, wholesalers, non-governmental organisations and producers in the importing countries, understand how domestic prices respond to changes in the external market. Understanding these factors may ultimately enhance efficient allocation of resources.

In addition, there is still limited research on how South African prices are transmitted to Swaziland's domestic prices. Yet, increased reliance on imports makes it so much more important to understand how external prices impacts local markets. It is therefore imperative to find out how the intervention of the NMC has impacted local producer and wholesale prices in relation to South Africa's prices.

1.2.2. Specific Problem Statement

The high domestic price in Swaziland serves as a production incentive for producers but affects maize consumers negatively. Despite policy interventions, which support local prices, Swaziland still relies on a significant amount of imports and is not self-sufficient in maize production. It has been well established in the research that government intervention affects market efficiency and integration. Market efficiency and integration have different meanings. Market integration implies the "*transfer of excess demand from one market to another, noticeable through physical flows, whilst efficiency is established when prices in two different markets differ by transfer costs*" (Li & Barrett, 1999). The two concepts are, however, closely related in that market integration is a necessary (but not sufficient) condition for efficiency in that the transfer of physical products should support price shocks from one market to another (Barrett, 2001). According to Stigler and Sherwin (1985) market integration is measured by theLaw of One Price (LOOP). This law states that in markets that are spatially removed, price shocks between markets should be transmitted on a one-for-one basis (Barrett & Li, 2002). Stated differently, for the LOOP to hold, cross-border price elasticities or slope should be unitary.

The ultimate question that therefore beckons from the above is: *How certain policies implemented in Swaziland impact on market integration and efficiency?* Findings from this could serve as a first step to ultimately determine the incidence and welfare effects of the policies in question.

1.3 Objectives of the Study

The main objective of this study is to examine the extent of (regional) market integration and price transmission efficiency in the Swaziland maize market. This will be done by evaluating the price transmission process from South Africa to Swaziland's domestic market in the presence of certain policies related to maize marketing and price-setting practices in Swaziland compared to a scenario of where there are no such policies. It therefore aims to inform how the involvement of government policies, which allow the existence of a monopoly importer and local price setting policies has effected in the integration of the two markets.

The specific objectives of this study are therefore to:

1. Determine if there is a long-run relationship/market integration, between Swaziland and South Africa, given the current market structure.

2. Should long-run relationship/market integration be found, determine what the short-run price dynamics are that cause price movement around the identified long-run relationship. These short term movements could provide indication on the efficiency of the price transmission process.

3. Conjecture about what prices might have looked like in the absence of the current pricing policies.

1.4 Hypotheses

Based on the section above the following hypothesis can be formulated

1. There is a long-run relationship between Swaziland and South Africa, given the current market structure and the relationship confirms that the LOP holds between South Africa and Swaziland.

2. Short-run dynamics correct deviations from the long run in a fast and efficient manner, given the current market structure.

3. Current policies are not hampering marketing integration and impeding regional price signals from flowing through to Swazi markets.

1.5 Benefits of the study

This study could inform policy makers in price decision making and strategy formulation in such ways that might encourage the efficient flow of resources in the white maize industry. According to Abdulai (2007), knowing the extent of price transmission between spatially separated markets is a prerequisite that ensures distributional balance between food-surplus and deficit regions in less-developed countries. This knowledge is important in the assessment of profit-seeking arbitrageurs' roles in food supply and price transmission. As mentioned earlier, this could inform policy debates regarding self-sufficiency versus food affordability.

1.6 The organisation of the study

The next sections of this study are organised as follows. The second chapter reviews the empirical findings and theories on market integration from previous studies. Chapter Three provides a snapshot of the white maize industry in Swaziland. White maize market reforms in

Swaziland, such as the intervention of the national maize corporation, which impact on supply chain and prices in the industry are also explained in that chapter. This serves to comprehensively contextualise the research problem. Chapter Four discusses the methods that are used in the analysis. It further provides descriptive statistics and analysis of the white maize industry. Chapter Five shows the empirical results. The last, Chapter Six, concludes with the main findings, policy recommendations and areas for future research.

Chapter Two
Literature Study

2.1 Introduction

This chapter provides a discussion of literature on spatial market integration and market efficiency. The first section of the chapter discusses market integration determined by spatial price transmission. In the last section, methods for price transmission analysis and empirical literature are reviewed. This serves to provide an overview of the different methods in time series econometrics, which can be used when considering spatial price transmission and market integration.

2.2 Spatial price transmission

2.2.1 Theoretical concepts related to price transmission

Price transmission between two trading markets that are allowed to trade freely is expected to adhere to the LOOP (Baffes, 1991). Therefore, the LOOP is often tested in the analysis of price transmission, assuming that two markets are related. If the LOOP holds it implies a one to one transmission of price shocks (Ardeni, 1989). The LOOP works well when trade flows occur every period (Ismet et al., 1998). It hypothesises that the price differential between two efficient trading markets is equal to the cost (such as transport cost, rent and other pertinent costs) of carrying out trade between two trading partners, after conversion into common currency (Fackler & Goodwin, 2001). In reality this rarely occurs, therefore it is necessary to consider weak law of one price, which notes that the difference in prices between two markets can be less than the cost of transacting. Weak law of one price is identified by a spatial arbitrage condition that ensures that prices of a commodity differ by an amount that is at most equal to the transfer costs with the relationship between the prices (Rapsomanikis et al., 2004). The LOOP is a necessary condition for arbitrage but not a sufficient one, to illustrate: if the price of a commodity is not different for different buyers then the law of one price holds without assuming full arbitrage. In any case, the LOOP can be represented in equation form as follows:

$$y_t = \beta x_t + c \qquad \text{Equation (1)}$$

Where y_t is the price in the surplus producing region, x_t is the price in the deficit or importing region and c is the transaction cost of trade.

According to Meyer (2006), a unitary elasticity, associated with equation (1) above, assumes complete transmission, in particular if all duties and transport costs are proportional to price (Brooks and Melyukhina, 2005), therefore the LOOP holds. It is usually assumed that primary commodities such as grains obey a perfect arbitrage rule, with instantaneous transmission. Take note that in the case of imports, it is expected that before transport costs are cleared, the local price should be higher than the world price. This implies that elasticity is less than one for perfect transmission, while the opposite holds for exports (Brooks & Melyukhina, 2005). If the two price series were found not to satisfy the LOOP, it does not imply that there is no market integration or price transmission.. Reasons for violation of the LOOP may be flow of information., geographical separation of markets, including transportation capacity, trade regionalisation and policies, also contributes to LOOP failures.

2.2.2 Spatial price transmission and government intervention

Policy interventions are common in many African countries, particularly in their grain markets. This can, in turn, affect the price transmission process into these countries (Rashid et al., 2010). Examples of state enterprises that engage in active policy implementation in African grain markets are the National Cereals and Produce Board (NCPB) of Kenya, the Agricultural Development and Marketing Corporation (ADMARC) in Malawi, and the National Maize Corporation (NMC) in Swaziland. These enterprises are responsible for pricing and marketing policies, which control the trade of maize between world and domestic markets, and hence affect price transmission. According to Amikuzuno and Ogundari (2012), sub-Saharan countries have government policies capable of controlling price movement between the world and domestic markets. Government policies, in particular marketing polices, are capable of isolating domestic markets and obstructing price signals from international markets, thus affecting market integration and price transmission (Conforti, 2004). As an example, high tariff levels may cause lower international price changes not to be transmitted to domestic markets, resulting in domestic prices being determined by local factors of supply and demand (Rapsomanikis et al., 2004). Other hand trade quotas may be more price distorting, as they inhibit trade flow rather than increasing the cost of imported products. In a less policy-controlled environment it is however expected that spatially separated markets, linked by trade, a price shock in one market will have the same or at least a proportional impact on the price of its trading partner. The elimination of domestic policy distortions narrows the gap between domestic and international prices for both imports and exports, which in turn encourages trade (Huang et al, 2009). This could ultimately encourage full market integration and price transmission, implying market efficiency.

In spatial price transmission, marketing efficiency implies no arbitrage opportunities to make profits, and as a result market prices in two locations only differ by the cost of transporting the commodity and other costs related to the transaction (Fackler & Goodwin, 2001). Abbott (2012) also supports the view that perfect transmission of price changes between two markets indicates the presence of no friction that might allow for efficient arbitrage. However, as mentioned above, markets may be inefficient due to government action, whether in the form of policies at the border, price support mechanisms or transaction costs (Vasciaveo et al, 2013). These factors could alter market efficiency by weakening transmission between domestic and world markets. Hence, the liberalisation of trade policies could encourage efficiency and reduce volatility of prices. The lack of market integration does not necessarily imply market inefficiency (Rashid et al, 2010). Moreover, market integration in spatially separated markets can be applied even when prices may not equilibrate across trading economies (Barrett & Li, 2002). As previously mentioned, policies are not the only factor that could result in market inefficiency. There are other factors could contribute to inefficiency, such as transaction costs and imperfect market information.

According to Mofya-Mukuka and Abdulai (2013), poor price transmission may arise from high transaction costs. Transaction costs include "*transportation and freight charges, risk premia, information gathering costs, negotiation costs and spoilage*" (Serra et al., 2006). Other transaction costs include import levies, such as Swaziland's 1 percent import levy. For staple food crops such as maize, transaction costs influence trade between the commodity's markets (Minot, 2011). Transaction costs hold economic agents back from adjusting prices continuously, especially menu costs, which are the costs incurred by firms in order to change their prices (Mofya-Mukuka & Abdulai, 2013). Therefore, transaction costs affect price transmission.

2.3 Modelling price transmission

Numerous studies to test spatial price transmission in the presence of policies, and without, have been carried out. Early research such as Blyn (1973), Ejiga (1977) and Monke and Petzel (1984) used correlation coefficients to test the extent of integration between markets. Correlation coefficients are used to test linear relationships between two variables (Minot, 2011). According to Blyn (1973), higher correlations between markets suggests more integration and vice versa. Ejiga (1977) postulates that spatially separated markets involved in trade should be correlated; hence, correlation coefficients may be used. According to Minot (2011) however, the use of correlation coefficients is not efficient since it assumes fixed transaction costs and fails to consider other factors, like trade policies, climatic variability, and inflation, which may prompt differences between markets. Hence, this technique could claim the integration of markets when they are, in fact, not integrated. Another limitation of this static correlation approach is that it assumes that instantaneous response in one market leads to changes in the other, and thus does not take lags in to accounts (Minot, 2011). Yet, a lag is usually expected between the price change in one market and the impact on another market. This results from the time taken by traders to notice the change and respond to it. Changes in international prices may take time to be reflected in the domestic prices. The poor ability of correlation techniques to measure price transmission led to the adoption of standard regression models as a means to analyse this.

Regression models tests for a linear relationship between variables. Mundlak and Larson (1992) and Gardner and Brooks (1994) used standard regression to do empirical estimations of the transmission of world food prices to domestic prices. Similar to the correlation coefficients, the regression models however failed to consider time lags. After the discovery of these problems, researchers developed time lag inclusive models. The most prominent study that made use of this method is Ravallion (1986). In this study, a dynamic regression model was used, making it the first distributed lag model that shows the long-run and short-run relationships between markets. This method is, however, not without shortcomings. Minot (2011), amongst others, point out that the method may result in misleading results of price transmission and market integration, in particular when the price series is non-stationary.

Time series techniques are an improvement of Ravallion's technique to measure the extent of market integration. Some techniques included under the time series umbrella and commonly used for price transmission analysis include Granger Causality test, cointegration test, and the Error Correction Model (ECM) models. These time series techniques can provide information on the links between market prices, the nature of the relationship, and the speed of adjustment over time and is therefore used to inform issues related to market integration and efficiency.

According to Stigler (2010), cointegration tests were introduced by Granger in 1982. Cointegration means that integrated series in a linear combination has a stationary error term. In essence, cointegration between markets implies that the dynamics of the price relationships in the markets converge in the long run. Engle and Granger (1987) introduced a cointegration methodology called the Engle and Granger cointegration test. Its procedure is done in two steps. According to Balke and Fomby (1997), the Engle and Granger method is convenient to examine long-run adjustments between markets. However, it only considers linear series and symmetric price transmissions. This makes the model less efficient when there is suspicion that there may not be symmetric adjustment in the prices due to factors that hinder efficient market integration transmissions, such as arbitrages from international to local markets, or vice versa (McLaren, 2013). This model considers two variables; hence recognises a single cointegration vector.

Johansen (1988) developed a multivariate cointegration procedure that determines the number of cointegration relationships based of maximum likelihood techniques, called the Johansen test (Stigler, 2010). Unlike the Engle and Granger technique, the Johansen method allows testing of two or more variables resulting in one or more cointegration vectors. Johansen's method actually accommodates variables of differing orders of integration, namely $I(1)$ and $I(0)$, permitting the analysis to test all variables (Johansen, 1995). According to Balcombe et al. (2007), this approach tests for linear adjustments, thereby often assuming constant transaction costs. Another limitation is that, similar to the Engle and Granger technique, the Johansen method only tests for co-movement and completeness of adjustment. Therefore, standard cointegration methods are incomplete without ECM.

Cointegration estimates a long-run relationship, but over the short run, there could be deviations from this equilibrium state. These short-run dynamics can typically be captured by estimating an ECM. Therefore, an ECM is an extension of the cointegration procedure. If the Engle Granger or Johansen testing reveals that there is a long-run relationship between two variables, then the ECM can be estimated for short-run estimates. This model simply determines the extent and magnitude on the adjustment of domestic prices in stabilising the relationship between international and local prices when there is a shock to one of the variables (Balcombe et al., 2007). According to Jaramillo et al. (2012), the ECM estimates short-term effects of one time series on another. An error correction model has an error correction term which measures the speed of adjustment to the equilibrium level. In a multivariate setup, as typically determined through the Johansen procedure, Error Correction residuals occur in vectors, such that they are called Vector Error Correction Models (VECM). The VECM is therefore an extension of the Johansen test. If the Johansen test indicates the presence of more than one cointegration relationship or vectors, then a VECM can be estimated. The VECM approach is typically used when you expect a bi-directional relationship between the variables included in the system.

There are numerous studies that have used cointegration methods and ECMs to measure the extent to which maize prices are transmitted between the world and domestic markets. These studies provide different possible links between world and domestic markets. Below is a short review of prominent studies that used time series econometric techniques to analyse spatial price transmission.

Minot (2011) measured the extent to which world prices are transmitted to grain markets in sub-Saharan African countries, including wheat, maize and rice commodities. The Johansen and VECM models were used in the analysis. The Johansen tests proved that 13 out of the 62 price series from the different sub-Saharan countries had a relationship with world prices, mostly in the rice market. The maize market had the lowest extent of integration, compared with rice and wheat. This is linked to the fact that African countries are closer to maize self-sufficiency than they are for rice, for which they rely on imports. This shows that countries that have good policy support for promoting self-sufficiency do not rely on imports; hence a low transmission of prices is expected. The findings in this study, particularly related to maize, gives guidance on the possible results of integration that can be expected between South Africa and Swaziland. This study also proves that not all policies lower the extent of price transmission between spatially separated markets.

Zakari, Ying & Song (2014) investigated the effects of regional and world prices (Benin, Chad, Nigeria and Togo) on Niger domestic maize prices. The Johansen test was used to test the number of cointegrating vectors, and for short-run adjustments, the vector error correction model was used. However, the maize series had one cointegration vector and speed of adjustment of prices to the long-run was 48 percent. The low rate of transmission could indicate that, among other factors, Niger depends more on local production compared import supplies. Among the four markets, only the Togo market showed a significant and negative effect on the Niger maize market price in the short run and induced a 10 percent price response within one month. The error correction term proved to be negative and statistically significant. The rate of correction was relatively high at 48.23 per cent, implying that shocks in the four markets induce an almost 50 percent price adjustment in Niger maize prices in the first period of adjustment. Nonetheless, observing other cereal markets in Niger, including those for millet, rice and sorghum, shows that low transmission is related to high taxes and regional protectionism also affecting imports to Niger, thus resulting in high domestic prices. This study confirms that government policies play an import role in the transmission of prices between spatially separated markets, and this affects food affordability through altered domestic prices. This could also be the case with Swaziland's marketing policy that protects domestic market in the form import quota and monopoly market. Therefore, Swaziland's marketing policy could encourage low price transmission between Swaziland and South Africa.

Motamed, Foster & Tyner (2008) used cointegration and error correction models to measure the transmission of maize prices from the United States to Mexico. It was hypothesised that US prices have a long-run relationship with those in Mexico. The hypothesis was rejected, implying that US maize prices do not significantly relate to Mexico's maize price. For this reason, the short run and weak exogeneity tests could not be done. The failure to prove a relationship between the two markets could mean that US imports are not responsible for Mexico's high maize prices. Protectionism through public policies could not be blamed because US exports to Mexico since 2006 were above a certain quota. This study proves that markets may be involved in trade, but not be integrated. This implies that there could be insignificant transfer of prices, thus failing to explain the behaviour of domestic prices. The information from this study gives an insight that Swaziland and South African white maize market could be trading, but not integrated due to unforeseen reasons that could need further investigation. On another note, it could happen that there is no cointegration because of the failure to account other factors that may cause non-linear adjustments. Therefore, other models such as AECM (Asymmetric Error Correction Model) and thresholds can be used.

An AECM can be used to dictate the presence of non-linear adjustments in a system. It indicates whether there is symmetric (linear) or asymmetric (non-linear) adjustment in the price system. The AECM is basically an extension of the ECM. It differs in that the short run adjustment processes is split into its positive and negative components, so that their coefficients may be used to test the hypothesis of symmetric adjustment using an F statistic. Symmetric adjustment occurs if a positive and negative shock in one market causes the same price response in the other market (Goodwin & Holt, 1999). Asymmetry in adjustment is however common in agricultural commodity prices characterised by their unstable nature and inefficient price transmission (Mundlak & Larson, 1992). The presence of asymmetries indicates inefficient transmission of prices and poor relationship between markets. There are a few studies that have used AECM's to test the extent and speed of price transmission between the world and domestic price commodities. For the sake of completeness some of them are touched on below.

Acosta (2012) used the AECM analysis to estimate the speed and magnitude with which prices are being transmitted from the South African to the Mozambique market. It was revealed that there is a long-run and asymmetric transmission between the Mozambican and South African white maize markets, with positive shocks being transmitted quicker than negative shocks. This was linked to the presence of trade policies and high import tariffs. This study gives an insight on the possible effects of government policies on (non-linear) price transmission. Therefore, it is necessary to test for non-linear adjustments when analysing transmission between Swaziland and South Africa, because the marketing and pricing policy could have an effect on the transfer of prices.

Rapsomanikis et al (2004) also used an AECM to test for non-linear adjustment of world and domestic Egyptian wheat prices. The null hypothesis of symmetry was rejected; implying that the domestic price reacts differently to changes in the world depending on whether these are positive or negative. It was found that increases in world prices passed-through faster and less completely to the domestic market prices, compared to decreases. The non-linear adjustment could result from the floor price policy implemented. It is such studies that one could possible derive expectations on the effect government policies on the price transmission process between South Africa and Swaziland.

The studies reviewed above focused on asymmetry in adjustment around a threshold of zero. More sophisticated computing techniques have however allowed for the threshold to be empirically determined and even for researchers to take account of more than one threshold. In a seminal paper Balke and Fomby (1997) introduced threshold models, which several authors have found effective to use for non-linear adjustment test between prices (Abdulai, 2000; Balcombe et al., 2007; Stigler, 2010). Since then there has been a vast amount of literature that incorporate threshold(s) into market integration and price transmission analysis. Some of them are touched on below.

Abidoye and Labuschagne (2014) used the threshold approach to measure the transmission of world maize prices to the South African market using three trade regimes namely autarky, import parity and export parity. It was evident that the relationship between the two markets showed the presence of nonlinearity and inferred that transaction costs and adjustment cost may be too high to justify equilibrium adjustments in the current period, thus causing a threshold band. This study gives emphasis to the necessity to consider the possibility of non-linear adjustments, in the form of an inactive or transaction cost band, when testing for price transmission between spatially markets. Traub et al. (2010), in turn, used a threshold technique to measure the extent of price transmission between South African and Mozambican wholesale maize grain prices. The null hypothesis of no threshold was rejected at 1 percent level. It was found that a trade volume threshold causes a regime shift in the price transmission relationship and therefore strongly supported the existence of a threshold effect. The regime shifts were divided into low and high imports. In the low-import regime, there continued to be no strong evidence of long-run price transmission between South African and Mozambican wholesale maize grain prices. This implies that any large deviations, within this regime, which exceed transaction costs, could continue to grow with no tendency towards equilibrium. However, in the high-import regime, under the cointegration assumption, there is evidence of a long-run price relationship between South African and Mozambican maize grain prices. These findings were not surprising, since two of the largest milling companies located in Maputo, are responsible for the majority of the volume of maize grain imported into Mozambique, from South Africa. From this study, it can be seen that factors, such as domestic policies promoting imports for food availability, could be responsible for thresholds in cointegration. The information from this study gives knowledge on the possible influence of Swaziland maize marketing policy on threshold cointegration. It is possible that this policy could cause non-linear adjustments or otherwise. Nevertheless, some studies that also used thresholds methods showed the possibility of symmetric adjustments, such as that of Balcombe et al(2007). This study used threshold models in examining the transmission of prices for maize, wheat, soya between Brazil and its trading partners, Argentina and the United States. A long-run relationship from the US and Argentine markets to Brazil was confirmed. The threshold error correction indicated that causality flowed from Argentina and US prices toward Brazilian cereal prices and the extent of error correction adjustment was small. However, generally there is weak transmission of maize and wheat prices from the US. There was symmetric adjustment between Brazil–US wheat and Brazil–Argentina maize price pairs. However, there was a presence of thresholds between Brazil–Argentina and Brazil–US wheat prices. In the case of maize, this could be because of the small volumes of maize traded to Brazil or the free trade agreement which was effective in the reduction of transaction costs when Brazil changed into a net exporter. The free trade agreement might have also led to the weak transmission of wheat prices. From this study one could possibly derive expectations on the effect of the elimination of domestic policies on the price transmission process between South Africa and Swaziland in that the removal of Swaziland's marketing policies could encourage strong(er) price transmission.

2.4 Conclusion

Price transmission describes market integration. In spatial price transmission, marketing inefficiency implies the presence of arbitrage opportunities to make profits, and as a result, market prices in two locations differ more than the cost of transporting the commodity (Fackler & Goodwin, 2001). This could be caused by a number of factors such as polices and transaction costs. The reviewed studies showed that the removal of policies could increase the extent of price transmission, though in some rare cases, this is not the case.

Price transmission analysis has evolved over time. Time series techniques, such as cointegration testing, and the estimation of error correction models, have are commonly used to analyse price transmission. There is a large body of research considering market integration and efficiency by conducting price transmission analysis and with increased computational capacity the standard methods have also become more sophisticated to allow for non-linearities in the underlying data generating process. This review has revealed these non-linearities can be caused by, *inter alia*, government policies and transaction costs. Whether or not these more sophisticated models are used, should be determined by testing the characteristics of the underlying data generating process.

Chapter Three
Swaziland's white maize industry

3.1 Introduction

This chapter lays out the background of Swaziland's white maize industry. Firstly, a detailed background on the organisation of the maize industry, before maize marketing policy reforms were implemented, is narrated. This is followed by the policy implementation process. Then, a section on the current organisation of the maize industry in the presence of maize marketing policy follows. The white maize pricing policy and the effects of the maize marketing policy will also be discussed.

3.2 Organisation of the maize industry before reform of pricing and marketing policy

Swaziland's agricultural industry has reflected a dualistic economy, described by a modern and a traditional economy (Economic Memorandum on Swaziland, 1975). It is further described that the modern sector was characterised by cash crops, such as tobacco, grown on individual tenure farms, whereas the traditional sector consisted of the Swazi Nation Land where maize is grown on a subsistence level. Generally, maize production was usually aimed at subsistence, rather than surplus, production (Sibisi, 1981). However, the government intervened and endeavoured to increase production.

The government of Swaziland has always involved itself with maize production. An example of this involvement was, amongst others, enabling the private sector to become the major driving force in local maize production. Through the Ministry of Agriculture and Cooperatives (MOAC), now called the Ministry of Agriculture, it also established programmes and policies to facilitate maize production (Dube & Musi, 2002). In this regard, the self-sufficiency policy and a few other projects were implemented right after the country's independence. The programmes aimed to transform the traditional sector into a commercial farming sector.

One of the projects implemented in 1973 was the Rural Development Areas Programme (African Development Fund, 1995). The development of the RDAs was to also aimed at addressing the problem of dualism, and was to be achieved through fiscal policy. The project aimed to maximise farmers' returns through increased production. Therefore, 29 Rural Development Area centres (RDAs) around the country were established under the project (De Vletter, 1984). These centres were responsible for agricultural production. The government subsidised inputs, such as fertiliser, credit facilities, hybrid seeds and tractor services. Regardless of the efforts made, staple food production decreased (Sachs & Roach, 1983) and prices increased. The Rural Development Areas Programme, as a general improvement policy, somehow did not attain its goals. However, government did not cease in its objective of improving production, hence subsequently, farmer cooperatives were established.

The cooperatives, controlled by the Central Cooperative Union (CCU), were maize assembly points, particularly for providing services in remote areas (Hlatshwako, 2010). Farmers gathered their maize at the cooperatives in preparation for processing by the monopoly commercial miller, which was the Swaziland Milling Company (Sithole & Apedaile, 1987). The white maize farmers had options to sell the maize, either in the formal or informal markets. The informal market consisted of neighbours, friends and informal millers, whereas the formal market comprised the Swaziland Milling Company and the farmer cooperatives. Farmers generally preferred the informal market because of the lack of modes of transport to send maize to the monopoly miller (Sachs & Roach, 1983). Despite the implementation of these programmes, maize production declined.

Over 1979/1980, global maize production declined, inducing an economic crisis (Grynberg & Motswapong, 2009). Agricultural importing countries, such as Swaziland, incurred higher costs. This resulted in a continuoued pressure on government revenues and food prices. Swaziland's maize imports, needed to satisfy local demand, increased. This trend persisted and over the next 15 odd years maize imports increased from an average of 25 000 tonnes from late 1987 to 127 300 tonnes in 1994 (African Development Fund, 1995).

Consumers and producers of maize were negatively affected by the occurrences mentioned above. Consumers paid high prices for food which in turn affects food affordability and ultimately nutrition. Producers, in turn, did not have the production capacity and access to infrastructure to benefit from high price levels in terms of increased supply. In this period Sibisi (1981) stated, "*Swaziland's greatest constraint on maize production is marketing*". Marketing proved to be extremely cumbersome and costly due to infrastructural and organizational issues. The low maize production and increased imports also proved that the goal of self-sufficiency appeared to be more remote than ever (MOAC, 1983). Therefore, the government initiated moves towards market liberalisation.

3.3 White maize marketing policy interventions

In light of the poor white maize marketing system, the government began a series of market restructurings in 1985. Although market reforms are supposedly based on liberalisation, with less or no government interference in the operations of the private sector, the agricultural sector of Swaziland seems to be an exception in this regard. The government is still involved in the maize marketing system. Market restructuring comprised of the redefining of the maize marketing policy. This involved the introduction of the National Maize Corporation (NMC), whose role was to assist in achieving self-sufficiency and regulating floor prices.

During market restructuring, in 1985, the government established two main institutions of the maize industry; the National Marketing Board (NAMBOARD), and the National Maize Corporation (NMC). The NAMBOARD had the responsibility to issue import licences and regularise agricultural markets. The NMC, in turn, controlled the maize milling sector. However, it contracted the Swaziland Milling Company because of the greater experience it had, compared with the infant NMC. As part of further maize marketing policy reforms in 1995, the government, however suspended the milling activities by Swaziland Milling Company because of it failed to satisfy consumer and producer needs (Magagula & Faki, 1999). In addition to this, the Swaziland Milling Company was also dissatisfied at this time because of the low-quality maize local maize available for milling. Hence, milling activities went back to the NMC. This did however not last long. Currently, the Swaziland Milling Company's Ngwane mills control the milling sector of the maize industry.

The redefining of the maize marketing policy led to the NMC gaining partial independent management. The organisation is a government parastatal and a monopoly importer. It runs on a day-to-day basis without interference from the Ministry in the government. This was implemented to insulate the domestic maize market, so that the quantity of maize imported does not distort domestic production. Even though NMC is responsible for the stabilisation of domestic prices, the government is the main controller of the floor prices (Oxford Policy Management, 1998). This renders the NMC a dominant actor in the maize supply chain, as it is the central organisation between producers and millers.

White maize import policies in Swaziland also included quantitative restrictions during the 1990's, but were suspended towards the end of the decade in order to increase maize availability in the country (Magagula & Faki, 1999). The government also removed import levies on some maize products, setting some maize products at 0 percent levies. Currently, there is 1 percent levy charged on white maize grains. The government went to the extent of banning white maize meal imports, in order to protect the domestic milling industry.

3.4 Swaziland's marketing chain

After continuous white maize market reforms, as discussed above, the marketing chain evolved into an excessively complex system, involving a number of different bodies, due to the historical reasons described in the previous section. As mentioned before, it is important to note that the market reforms did not liberalise the white maize market. This is illustrated in Figure 3.1 and will be discussed in this sub-section.

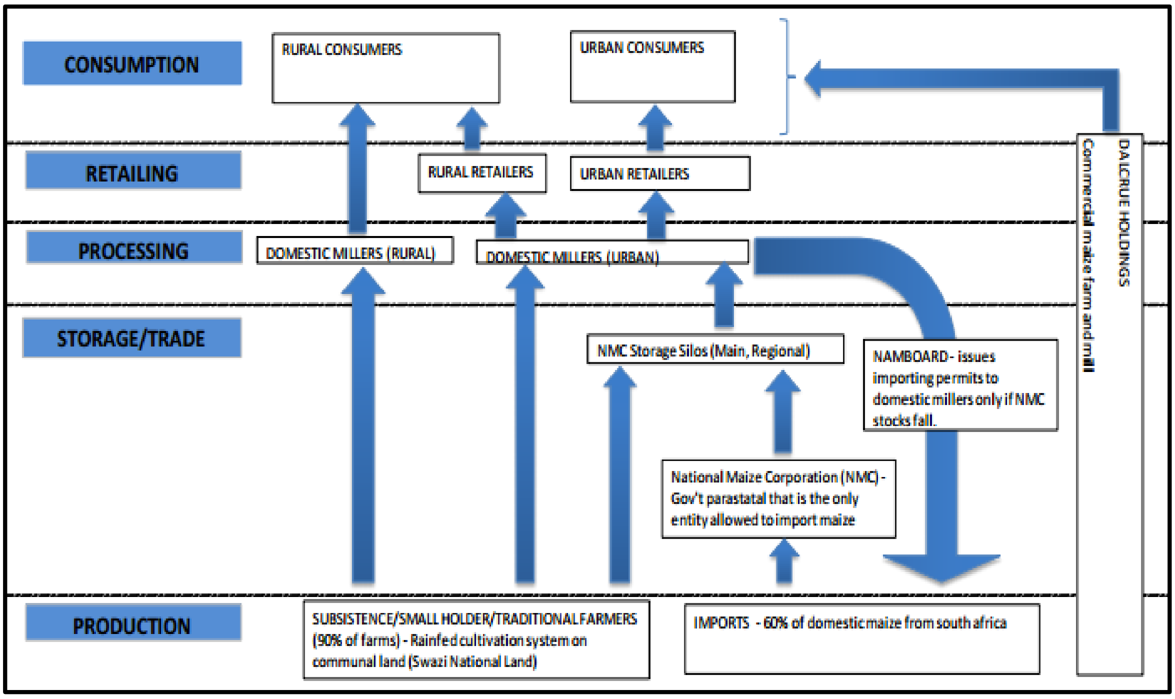

Figure 3-1: Swaziland's white maize supply chain

Source: JADAFA (2014)

3.4.1 White Maize production in Swaziland

Maize is the staple food in Swaziland and contributes 60 percent of the total dietary requirements of the Swazi population. In addition to this, maize production constitutes more than 95 percent of the country's entire cereal production (Mano et al., 2003). The crop is cultivated on both the Swazi Nation Land (land controlled by chiefs) and title deed land (privately owned land). It covers an area of 40 percent controlled land and 60 percent of privately owned land (Magagula et al., 2007). In 2011, the average yield per hectare in the Swazi Nation Land area is 4.22 tonnes, whereas the title deed land areas have an average of yield of 9.75 tonnes (Dlamini & Masuku, 2011). As shown in Figure 3.1 , about 90 perent of the total farms available in Swaziland are in the Swazi Nation Land area, where the crop is rain fed. This contributes to the low maize production, leading to the 60 percent domestic maize imports from South Africa. Privately owned farms produce more effectively than the customary owned farms do. This is because private farms have all the necessary resources to produce higher yields.

Swaziland has experienced shortfalls in domestic production of maize since 1985 (Mashinini et al., 2006). According to the Vulnerability Assessment Committee (VAC, 2012), in the year 2012, there was a 34 percent shortfall in maize production in Swaziland, which had to be met through South African imports. About 80 percent of the rural population in Swaziland do not have enough maize for consumption (JADAFA, 2014).

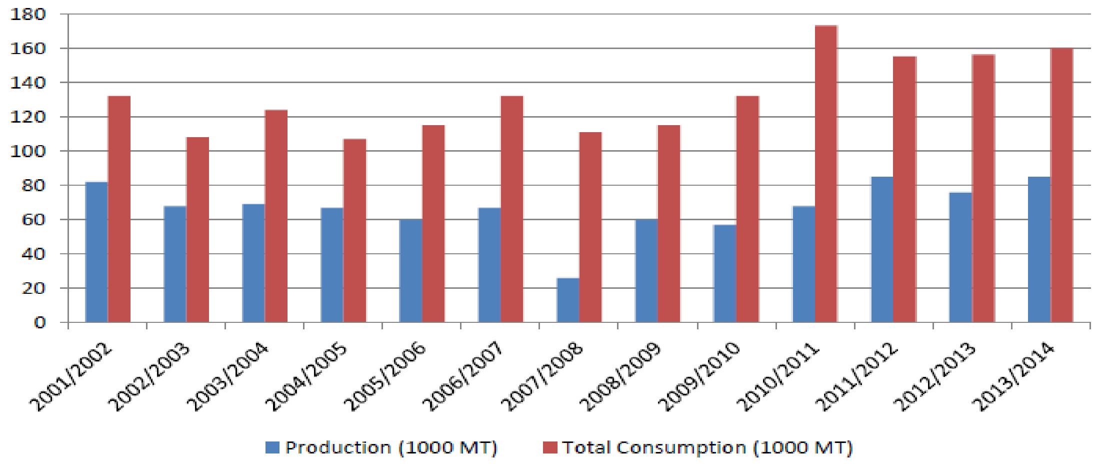

Figure 3-2: White maize production and total consumption

Source: JADAFA (2014)

As shown in Figure 3.2 , the domestic demand trended upwards between the years 2001 and 2013. Swaziland has an average shortfall of 65 000 metric tons per year, with a constant domestic production of around 80 000 metric tons

Maize grown by farmers is sold to either to the NMC or the informal sector. FANRPAN (2013) states that smallholder maize farmers established an association which assists in selling their white maize produce. Through information dissemination and access to credit, farmers' productivity is improved.

3.4.2 White maize processing and retailing

As illustrated in Figure 3.1 , traditional small-scale farmers usually sell their maize grains to roller millers found in both rural and urban areas. Commercial farmers prefer to use the services of formal maize millers. Both small scale and commercial farmers, however seems to prefer working through the NMC because of the subsidised producer prices (NMC, 2014). Formal maize millers buy maize at the selling price dictated by the NMC, whereas informal sales could be well below this prices. Formal milling operations include the Ngwane mills, Universal Milling, Nkonyeni Milling, and Dalcrue Holdings (JADAFA, 2014). JADAFA (2014) further states that the Ngwane Mills Ltd and Universal Milling Company dominate the milling market, with market shares amounting 60 percent and 25 percent, respectively. Millers sell their products to retailers in both urban and rural areas.

3.4.3 White maize trade

3.4.3.1 Local white maize trade and storage

In the traditional sector, after the maize harvest, the farmers retrain sufficient amounts for own consumption to feed them until the next harvest. They have on-farm storage facilities, such as tanks. Surplus production is either sold to the NMC or to private buyers, with most sales occurring between May to August. As shown in Figure 3.1, the NMC has five silos, located in the four geographical regions of the country. The maize is stored in the regional silos and then later taken to the main silos in Matsapha. All five silos have a combined capacity of 23 500 metric tons, which is enough to supply local millers (FANRPAN, 2013). The maize collected from farmers is sold to individual customers and millers in different quantities. Most commercial farmers prefer channelling sales through the NMC because of the comparatively high prices established by the subsidised floor price (Mukeere & Dradri, 2006). Using its income, the corporation subsidises the producer prices.

The NMC operates as a parastatal, specialising in white maize grain trading and rice. Distinct from most Swazi parastatal organisations, it has no basis in any Act of Parliament (Obi, 2011). The National Agricultural Marketing Board and the Ministry of Agriculture are the two major shareholders of the corporation (Oxford Policy Management, 1998). The NMC's main purpose is to provide marketing services to local maize farmers. It also ensures the provision of good quality maize meal to the nation. The organisation is the sole authorised importer of white maize grain into the country. Hence, it is the central organisation that controls the white maize market in Swaziland.

3.4.3.2 White Maize external trade; Swaziland and South Africa

Swaziland imports white maize from southern African countries, such as Zambia, South Africa and Namibia. However, most of Swaziland's white maize including GMO maize imports are from South Africa (NMC, 2014). Through the trade policy, the country regulates the maize imports while maintaining the terms of the South African Customs Union (SACU)[1]. SACU was established in 1910 to enhance local agricultural production and trade (SACU, 2012). These countries are also in the same regional trading bloc, the Southern African Development Community (SADC) (Makombe, 2011). This implies that, by default, Swaziland and South Africa are in a free trade area, such that no customs or excise tariffs are applicable on goods originating from either of them, hence eliminating cumbersome taxes. Despite this, depending on the commodity, SACU members are charged levies when exporting to Swaziland. Through the maize marketing policy, the government of Swaziland has imposed quantitative quotas and levies as policy instruments for regulating maize. However, the fragmentation of the SACU maize market protects producers at the expense of consumers (Grynberg & Motswapong, 2009).

Since Swaziland and South Africa have a Common Monetary Area Agreement, there is direct convertibility of the Swazi Lilangeni currency into the South African Rand (Wang et al., 2007). This explains the responsiveness of maize imports, from South Africa, to domestic shortfalls in Swaziland, implying that availability of foreign exchange is not a constraint to commercial imports from South Africa. Figure 3.3 provides a summary of the flow of white maize from South Africa to Swaziland.

[1] The common customs area comprises the countries of South Africa, Botswana, Namibia, Lesotho, and Swaziland.

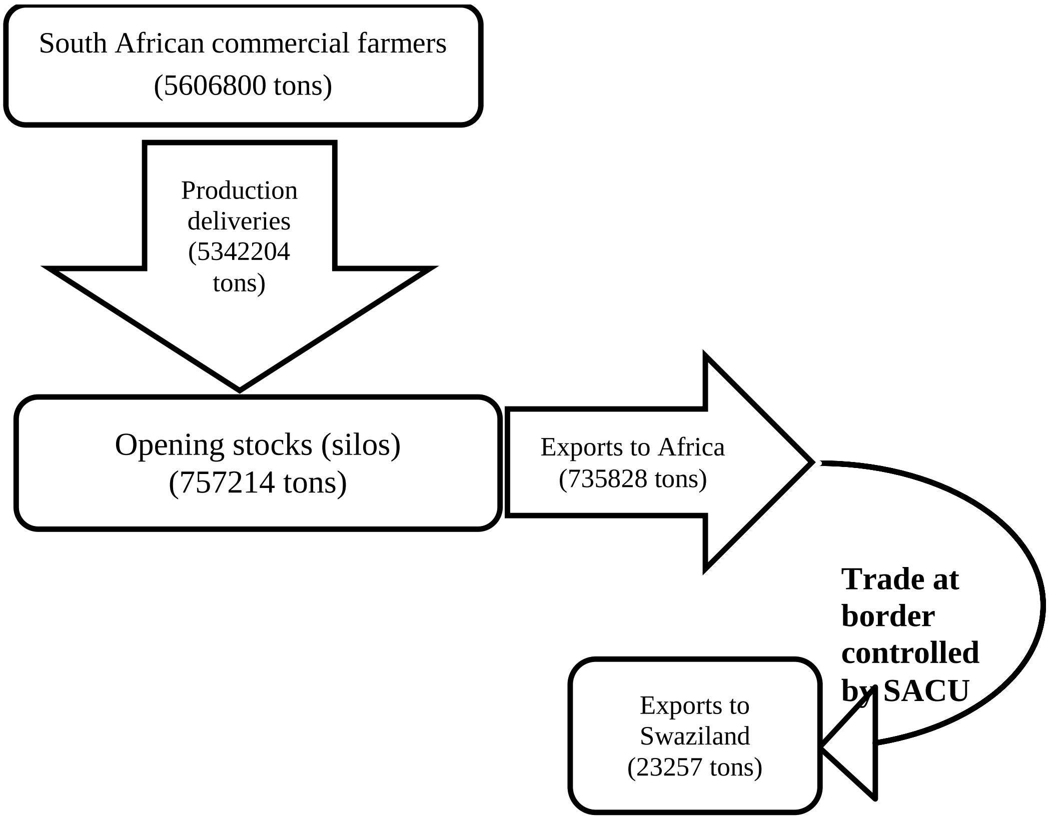

Figure 3-3: White maize flow diagram: From South Africa to Swaziland 2013/2014

Source: South African Grain Information Service (SAGIS)

3.5 Swaziland white maize pricing policy

The government introduced a maize pricing policy which determines floor prices. There were two types of maize pricing policies; the pan-seasonal (white maize prices are maintained at the same level throughout the year) and pan-territorial (white maize prices are the same in all areas of the country) (Sithole & Apedaile, 1987). Currently, only the pan-territorial policy is active. Because the unpredictable climatic variations result in unpredictable price shocks in agricultural commodities, the government decided to scrap the pan-seasonal pricing policy (FANRPAN, 2003). This implies that severe droughts prices may change in a season.

The maize pricing policy stipulates that through the Ministry of Finance, government regulates the maize producer and consumer floor prices. Swaziland's white maize market has an official price and an informal price, also called the open market price (Mabuza et al, 2009). The informal sector determines the open market price, whereby producers sell privately to consumers and millers. The open market price is set by demand and supply. The official price consists of the buying and selling prices, and is guided by the pricing policy. A true reflection of the price setting system is illustrated in Figure 3.4 .

The buying price, also referred to as the producer floor price, is set by the Marketing Advisory Board which includes the NMC, Ministry of Agriculture, National Marketing Board, consumer associations, and farmer and miller representatives. However, the parliament gazettes the final buying price, while taking into consideration the needs of supply chain actors. The producer floor price protects farmers by ensuring that their produce is sold. As shown in Figure 3.4, producers sell dry white maize grains to the NMC, which is the main grain trader in the country, at the buying price, as mentioned before. As previously discussed, the NMC also subsidises the buying price.

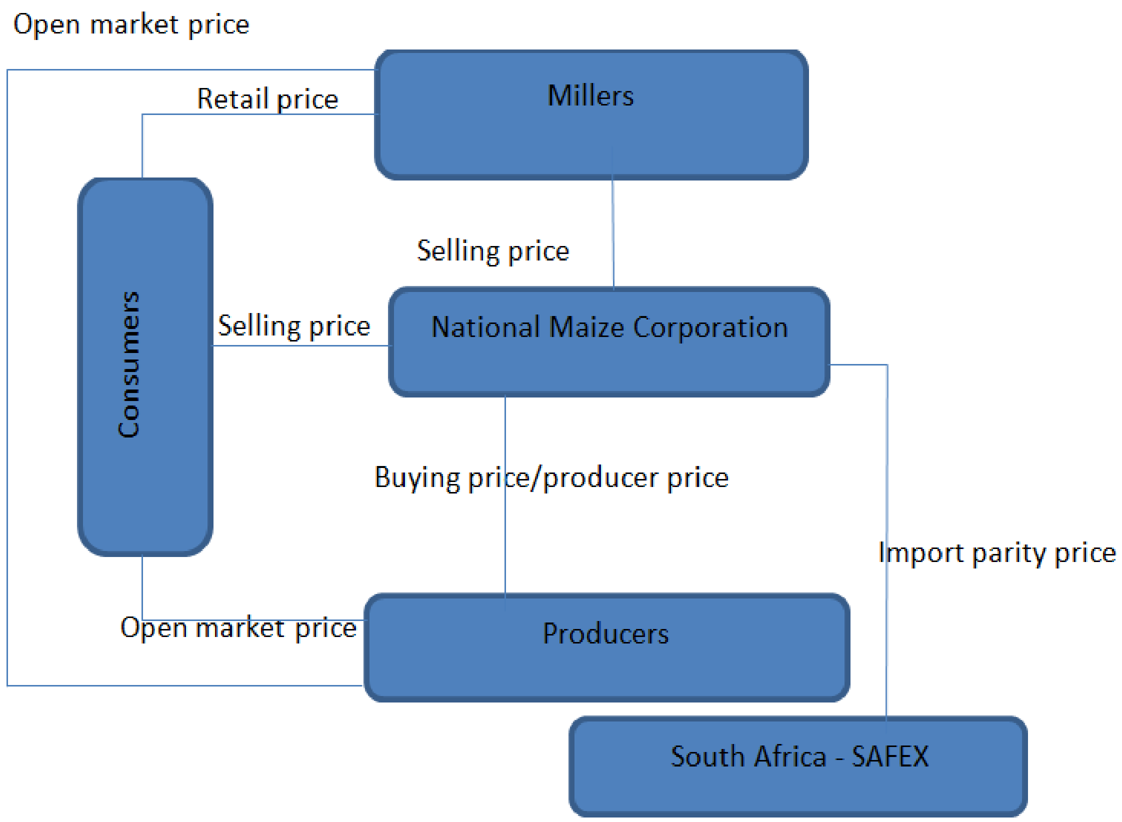

Figure 3-4: The pricing system in the white maize industry

Source: Author’s compilation

The selling price is the price received for white maize sales by NMC from millers and consumers, as illustrated in Figure 3.4. This price is entirely regulated by the NMC and the Public Enterprise Unit (PEU) of the Ministry of Finance provides guidance so that the corporation can cover its operational costs. In the past, a mark-up pricing strategy was used to set the selling price, where 10 percent was added to operational costs. However, over the years, price adjustments have been made with reference to SAFEX prices and other factors.

The selling price effectively reflects the SAFEX price, since during its setting; the minimum and maximum monthly SAFEX prices of the previous season are averaged. Thereafter, the average maximum is used as a reference price to set Swaziland's selling price, while considering other factors such as production costs. The selling price will be set higher than the SAFEX averaged price. As a result, Swaziland's domestic prices are usually set higher for the whole year, relative to the SAFEX prices, to anticipate the uncertainty in South African white maize futures (FANRPAN, 2003). In a particular season, should SAFEX prices rise close to the selling prices in Swaziland, price adjustment will be done. Thus, there is no fixed percentage on the adjustment, and there are no other factors that may influence the prices which are taken into consideration.

As mentioned above, Swaziland's domestic prices (the selling and buying prices) are determined by the import parity price. The import parity price, in turn, is the SAFEX price and the transport costs, plus levies. The buying price is mainly based on the import parity price plus a small compensation for the cost of production incurred by farmers (NMC, 2005). Likewise, when setting the selling price, the import parity plus NMC's operational costs are considered. This results in higher selling prices, which assists the corporation to cover its operational costs and to make positive earnings to cater for subsidies. The NMC sets the selling price above import parity prices so that the domestic market is shielded from world markets, as shown in Figure 3.5. The NMC is the central organisation in the supply chain, as it intermediates between the millers and the producers in the white maize market. It encourages farmers to store their grain for sale during periods of scarcity.

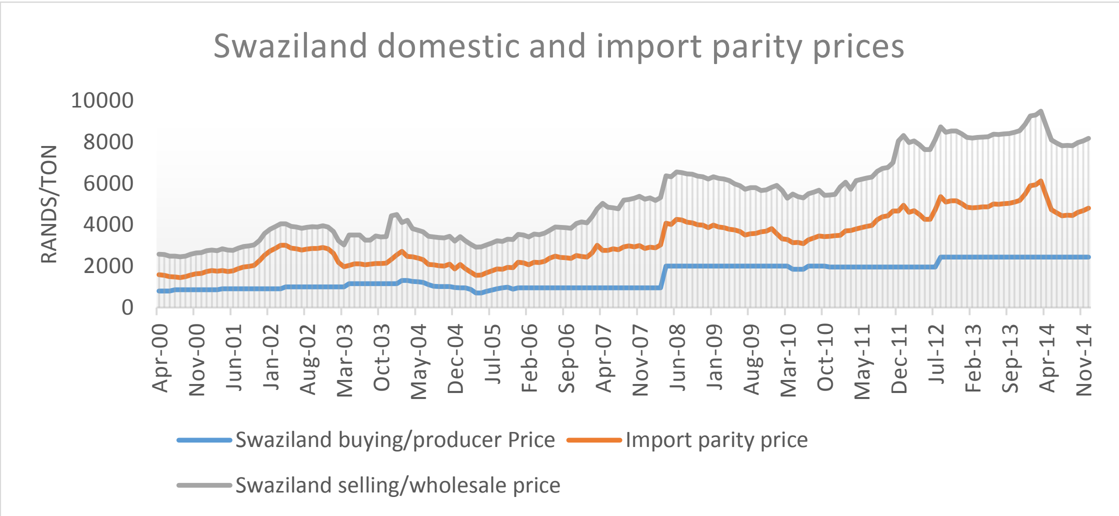

Figure 3-5: Showing import parity, selling and buying price

The exchange rate and the inflation rate also are considered during price setting. However, since Swaziland and South Africa are members in the same common monetary agreement, there is an equal exchange rate, hence, no mathematical convertibility is required. If the exchange rate of South Africa depreciates, Swaziland's also has the same effect, such that the 2000–2002 South African weakened exchange rates led to a rapid increase in the price of maize and the increase had a corresponding effect on the price band within which the domestic price moves. According to Ardeni (1989), when there is a fixed exchange rate, a change in the unit price of one currency is reflected in the counterpart's foreign currency.

3.6 The effects of maize marketing policy interventions on Swaziland's white maize prices

Generally, commodity prices are determined by the interdependence of the supply and demand functions (Cramer et al., 1997), but these supply and demand functions would have been previously influenced by agricultural strategies and policies. As is the case with the Swaziland maize industry, the restructuring of the maize marketing policy, leading to the intervention of the National Maize Corporation, has had consequences on the prices, thus affecting supply and demand.

Short-term buying price variations are primarily a result of producer subsidies. As an example, in the 2012/2013 season, around July, prices escalated. This was caused by the NMC subsidy of the producer prices, set to encourage greater farmer production (NMC, 2014). Usually, prices are changed when there has been a severe white maize shortage in the previous season; hence, increased producer prices are said to incentivise higher productivity. As is evidenced in Figure 3.6 , prices are set for the whole year, except in particular seasons for reasons mentioned earlier.

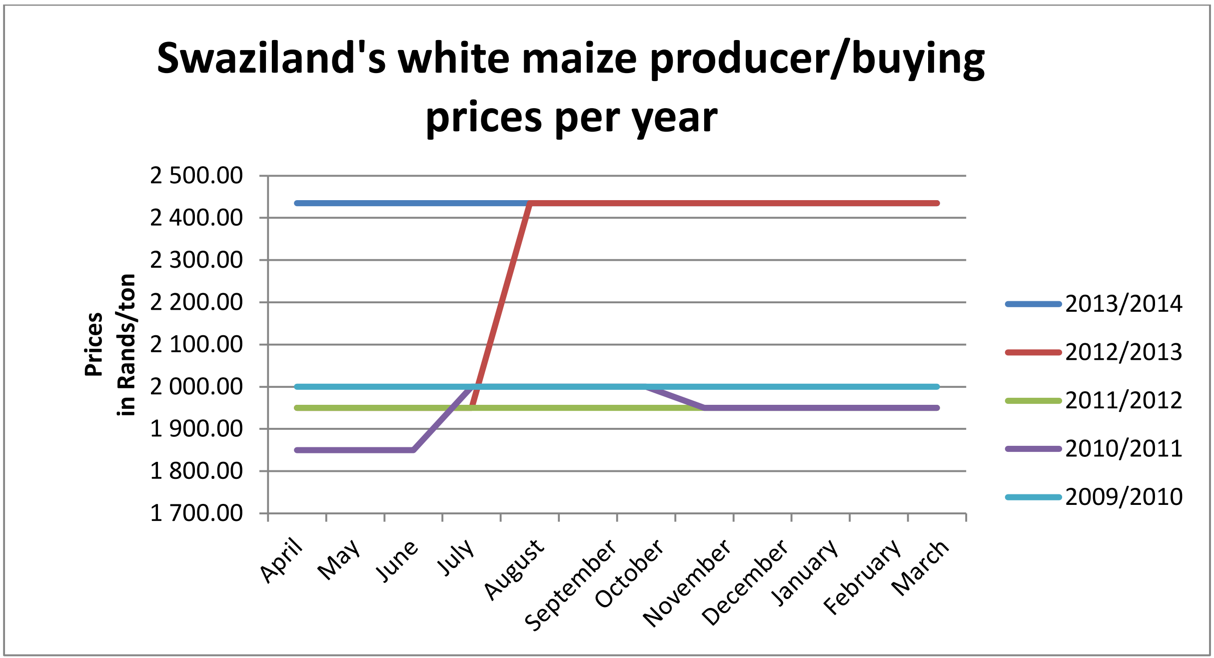

Figure 3-6: White maize producer prices by NMC in Rands per metric tonne (1000Kg)

Source: NMC, 2014

Selling price hikes within a season, occur when the industry endeavours to compensate local farmers for high farm inputs by setting a higher price, which is not related to the market value of the maize (NMC, 2010). The corporation is in effect duty bound to buy the resulting expensive locally produced maize in order to promote local production of maize by providing a guaranteed market through paying higher producer prices/buying prices than those in the rest of the SADC region. To compensate for the high buying prices paid by NMC, it sets the selling prices high. Subsidising producer prices also leads to ripple effects, on NMC selling prices, and retailers and consumer's prices. This alters the consumption patterns of maize consumers such that they prefer to use informal market channels to buy maize, and rather opt for consumption of other cereals, such as rice (FANRPAN, 2003).

The high local selling prices have led to unnecessary conflicts in the white maize industry. The current maize marketing policy is partly responsible for the conflicts, as it gives the National Maize Corporation (NMC) monopoly rights in the importation of maize. This was seen in the 2002 maize marketing season, when millers challenged the single channel of white maize importation. The NAMBOARD was flooded with applications for maize import permits. The inundation of white maize applications were mostly from millers who were not satisfied with local selling prices, which they claimed were high. Swaziland's domestic prices were set at more than SAFEX prices, resulting in millers desiring to import less-costly maize from South Africa. The implication is that farmers and millers could purchase maize directly from South Africa at a cheaper price, consequently lowering raw materials costs for millers (Mukeere & Dradri, 2006).

3.7 Conclusion

In Swaziland, government interventions in the form of maize marketing and pricing policy, have affected white maize prices for the last five decades. Progressive policy formulation and implementation has led to a current situation where imports occur through a single channel and there is a dual pricing system, namely the official and informal price. The informal price is the open market price set by the demand and supply. The official price is, however, controlled by the pricing policy under the pan-territorial pricing system implemented and administrated by the NMC. The NMC and other stake holders abide by the pricing policy when setting domestic prices. The domestic prices include NMC's selling (to millers and other customers) and buying (from maize producers) prices. These are the standard prices used in the Swaziland's white maize industry. These prices are however high compared to regional levels.

The high maize prices are also linked to the maize marketing policy controlling the NMC. The presence of NMC prevents the role of competition in the supply of maize imports since the corporation is a monopoly importer. Although this is in principle good measure to sustain high prices in order to stimulate a positive supply response, Swaziland is increasingly relying on imports to fulfil its demand for white maize. As a result consumers in Swaziland are burdened with the incidence of buying maize (meal) at high prices. This, in turn, has very definite implications for food affordability and nutrition.

Chapter Four
Methodological Approach

4.1 Introduction

This chapter gives an overview of the time series methods that were used to analyse price transmission. The techniques utilised to determine spatial price transmission, in the presence of the maize marketing policy, and when the market is not regulated, are narrated. The methods assist in the description of the relationship between South African and Swaziland white maize prices in the presence of the maize marketing policy that allows for monopoly imports by the NMC. In addition to this, time series methods were also used to analyse a hypothetical scenario where the above-mentioned policy measures did not apply.

4.2 Study area

This study focused on South African average monthly spot prices and average monthly Swaziland's wholesale prices from 2000 to 2014. South Africa was chosen on the basis that, currently, almost 90 percent of Swaziland's commercial white maize grain imports are from this country. It should be noted that this imports here does not include food aid.

4.3 Data sources

The 2000–2014 time series range was chosen on the basis that this was the only range of the data series available from NMC. The NMC selling, NMC import parity and world price series figures were used. The NMC's selling/wholesale and import parity prices were used because the NMC is the only commercial white maize importer. The import parity prices are based on cost, insurance, freight and import levy, as presented in Table 4.1. Border prices represent arbitrage opportunities, thus they are appropriate to test the LOOP. Unlike the study of Goodwin et al. (1990), where they used expected parity prices, this study used actual import parity prices. The world prices are provided by South African SAFEX prices, therefore, were sourced from the SAFEX website. NMC's Producer/buying prices could not be used because, unlike the selling price, these prices are subsidised, such that they are higher than import parity prices. The higher producer prices might make it difficult to determine the transmission between the world and domestic prices. To model transaction costs, actual transportation costs are used. The other supportive data was collected from published and un-published documents, and from Swaziland's Ministry of Agriculture, NMC and the National Marketing Board.

Table 4-1: Summary of prices used and their sources

Prices	Price Formation	Source
Swaziland wholesale price	NMC selling price	The NMC
South Africa monthly spot price	Average of daily closing price in the market	SAFEX website
Estimated Import parity price (in a free trade between SA and South Africa)	SAFEX white maize spot price, insurance import levy and transport cost	SAFEX, Swaziland National Marketing Board and South African industry petroleum services (Author compiled information from these sources)

4.4 Data analysis and methods

Time series techniques have been used to test the components of price transmission and thus ultimately assess the extent of market integration. Various sub-components of time series analysis, required to analyse price transmission are therefore discussed below. Two test scenarios were considered namely a transmission test in the presenece of current the marketing and pricing policies and a hypothetical scenario where these policies are relaxed. Table 4.2 shows a summary of the variables used.

Table 4-2: Summary of variables used for price transmission

Price transmission test scenario	Dependent variable	Independent variable
Swaziland's white maize marketing and pricing policies considered	Swaziland white maize selling price	South African spot price
Swaziland's white maize marketing and pricing policy not considered	Swaziland's import parity price	South African spot price

4.4.1 Unit root test

In price transmission analysis, data in levels could be combined in a regression analysis, but those regression results might be spurious if variables are non-stationary or has a unit root. In order to establish the univariate properties of the data the order of integration of each variable needs to be determined. If the order of integration of a variable is 0, it implies stationarity. If the order of integration is 1 or more, it means that the variable under consideration is non-stationary. Variables that are integrated of order 1 can be differenced in order to get a stationary data generating process. In order to estimate a long-run function that is potentially cointegrated, the two series need to be integrated of the same order.

According to Engle and Granger (1987), the Augmented Dickey Fuller (ADF) tests can be applied to determine the order of integration of each individual price series. Therefore, the Augmented Dickey-Fuller (ADF) unit root test is applied to test for unit root in the series. Equation (2) , with a constant and trend, presents the ADF test.

$$\Delta y_t = \alpha + \delta T + \beta_1 y_{t-1} + \sum_{i=1}^{P} \beta_1 \Delta y_{t-1} + \uparrow \varepsilon_t \qquad \text{Equation (2)}$$

where:

$\Delta y_t = y_t - y_{t-1}$, $\Delta y_{t-1} = y_{t-1} - y_{t-2}$, and $\Delta y_{t-2} = y_{t-2} - y_{t-3}$, etc.

ε_t is pure white noise term

α is the constant-term

t is the time trend effect,

δ is the optimal lag value which is selected on the basis of Schwartz information criterion (SIC).

The null hypothesis is that $\beta_1=0$. The alternative hypothesis is: $\beta_1 < 0$. If the null hypothesis of the unit root at level form is rejected, then the price series would be considered stationary (Gujarati, 2010). Therefore, differencing would not be necessary.

4.4.2 Cointegration

4.4.2.1 Engle-Granger Test

In order to determine if there is a long-run equilibrium relationship between variables it needs to be established if the two series is question are integrated. There are various tests for cointegration. One of the most intuitive methods to establish if cointegration is present is the Engle-Granger method. A drawback of this method is that it does not consider the variables as a system, but test for a unidirectional relationship. In the case of establishing a long run relationship between South Africa and Swaziland, this might be acceptable since trade flows only from South Africa to Swaziland, in the case of white maize. The cointegrating function should therefore be set up accordingly.

A general model, to test for Engle-Granger cointegration is represented as Equation (3);

$y_t = \alpha_0 + \alpha_1 x_t + \varepsilon_t$ t= 1, 2…n Equation (3)

where y_t, is the dependent variable at time t, α_0 is a constant term, α_1 represents the rate of change in x_t with respect to y_t, x_t is an independent variable at time t and ε_t is a random error term (accommodating any other factors that could affect the relationship between the two markets). The study will have two models of such kind representing, one when the maize marketing and pricing policies are considered and the other when they are not. The dependent y_t represents Swaziland white maize price in the policy scenario and the import parity price without policy consideration. The independent variable x_t represents South African spot prices used in both scenarios, when policies are present and removed. According to Engle and Granger (1987), the random error is also called the price spread and should be stationary.

As a result, an estimate of residual $\Delta\varepsilon_t$ is obtained by regressing y_t on x_t (as shown in Equation (3)).

Secondly, the residual is tested for unit root (shown in equation (4)).

$\Delta\varepsilon_t = \rho\varepsilon_{t-1} + \mu_t$ Equation (4)

where ε_{t-1} are lagged values of order one of the residual, ρ is the parameter, which is the parameter that you consider in order to establish stationarity or not and μ_t are errors obtained in fitting differenced residuals. Unit root tests are applied to ε_t to test for stationary of the series. If the residuals are stationary, then the two price series are said to be cointegrated. This signifies that, between the two series, there is a price adjustment mechanism that allows them to converge to their long-run equilibrium relationship.

4.4.3 Error correction model (ECM)

The test discussed above analyses the long-run features that may be present between variables. It is however expected that there would be deviations from this long run relationship in the short run. This can be captured by estimating an Error Correction Model

(ECM). The ECM permits the use of lags of the various variables included in the model. A generic representation of an ECM is presented in Equation (9).

$\Delta y_{t=} \alpha+\theta(y_{t-1} - \gamma x_{t-1})+\delta(x_t - x_{t-1})+v_t$ Equation (9)

Where, for the purposes of this study, α is a constant term, Δy_t is the change in dependent variable at time t, y_{t-1} denotes lagged dependent variable. The parameter x_{t-1} represents lagged independent variable. The error correction term which is also the residual estimated from the OLS equation is represented by $(y_{t-1}-\gamma x_{t-1})$. The parameter θ measures the speed of adjustment of the domestic price to its long-run equilibrium adjustment. According to Krivonos (2004) the speed of adjustment indicates downward correction when y_{t-1} exceeds γx_{t-1} and upward when γx_{t-1} exceeds y_{t-1}. For this reason the speed of adjustment should maintain a negative value. The parameter δ is a short-run dynamic parameter. Since the ECM only measures the speed at which one variable returns to its long run path with another variable, then AECM could be used in the analysis of nonlinear adjustments.

4.4.4 Asymmetric Error Correction Model (AECM)

This model specification tests for non-linear adjustment to a long run equilibrium. This test caters for negative or positive shocks that could influence speed of adjustment differently Granger and Lee (1989) and be represented as follows:

$\Delta y_t = \mu_1+\alpha^+(y_{t-1} - \beta x_{t-1})^+ + \alpha^-(y_{t-1}- \beta x_{t-1})^- +\sum_{i=0}^{k} \delta\Delta x_{t-i}+\sum_{i=0}^{n} \delta \gamma y_{t-i}+ v_t$ Equation (10)

Where, μ_1 is a constant term, v_t is a white noise error, $(y_{t-1} - \beta x_{t-1})^+$ and $\alpha^-(y_{t-1}- \beta x_{t-1})^-$ are errors or divergences that reflect positive and negative disequilibria, respectively. The lagged differenced domestic (y_t) and world (x_t) price variables are included to ensure that errors are white noise and the model is well specified. The parameter δ denotes the short-run price transmission elasticity. The parameters α^+ and α^- represent the error correction coefficients. In the AECM, symmetry in transmission implies that $\alpha^+=\alpha^-$, thus this is the null hypothesis. If this hypothesis is rejected asymmetric adjustment exist. Asymmetry in adjustment occurs when there are negative and positive divergences from the long-run equilibrium between y_t and x_t and result in changes in y_t that poses different magnitudes.

4.5 Summary of methodological Approach

This subsection shows a summary of the methodological approach for price transmission analysis.

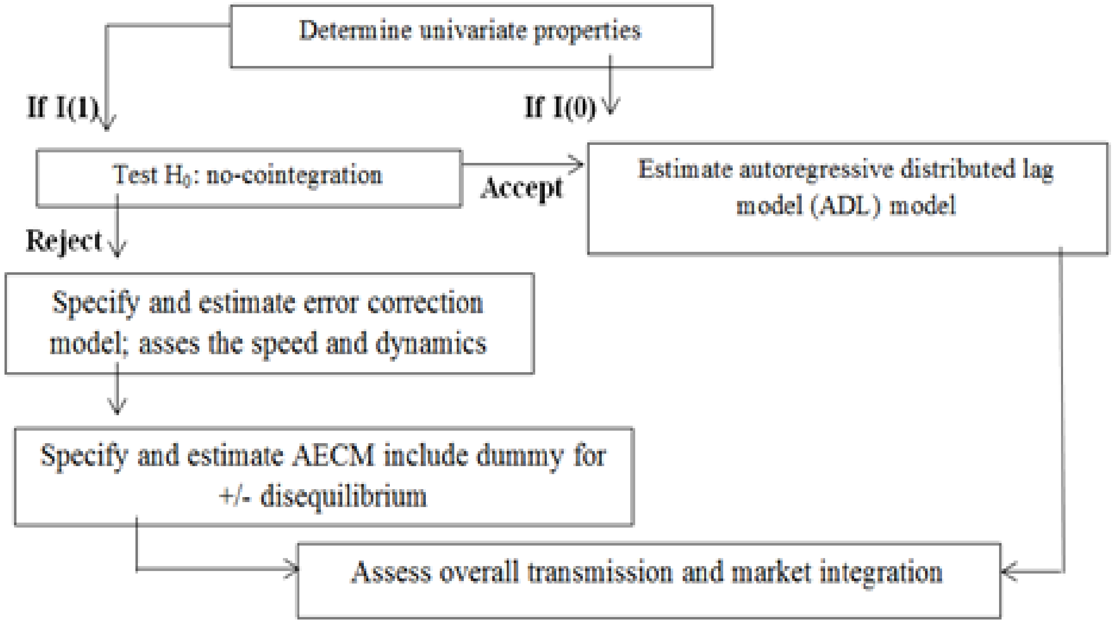

Figure 4-1: Showing a summary of methods used for analysis

Source: Rapsomanikis, Halam and Conforti (2004)

4.6 Descriptive statistics

This sub-section presents major trends and an analysis of the South African white maize spot prices and Swaziland's domestic prices. Analysing the statistical techniques assist in formulating *a priori* expectations. Monthly time series were used and measured in Rands/kilogram (R/kg).

4.6.1 The trends and analysis of South Africa and Swaziland white maize wholesale prices

From Figure 4-2, it appears that there is a slight correspondence between domestic market prices and world/ South African prices, in particular for the years 2006-2012. However, the Swazi white maize prices exhibit mostly yearly adjustments. This proves that Swaziland's white maize economy is far from open. Deviations (price gaps) are more noticeable in the months of February, April, May, June and July, where South African white maize spot prices usually declines as a result of the size of new seasons harvest being known and delivered.

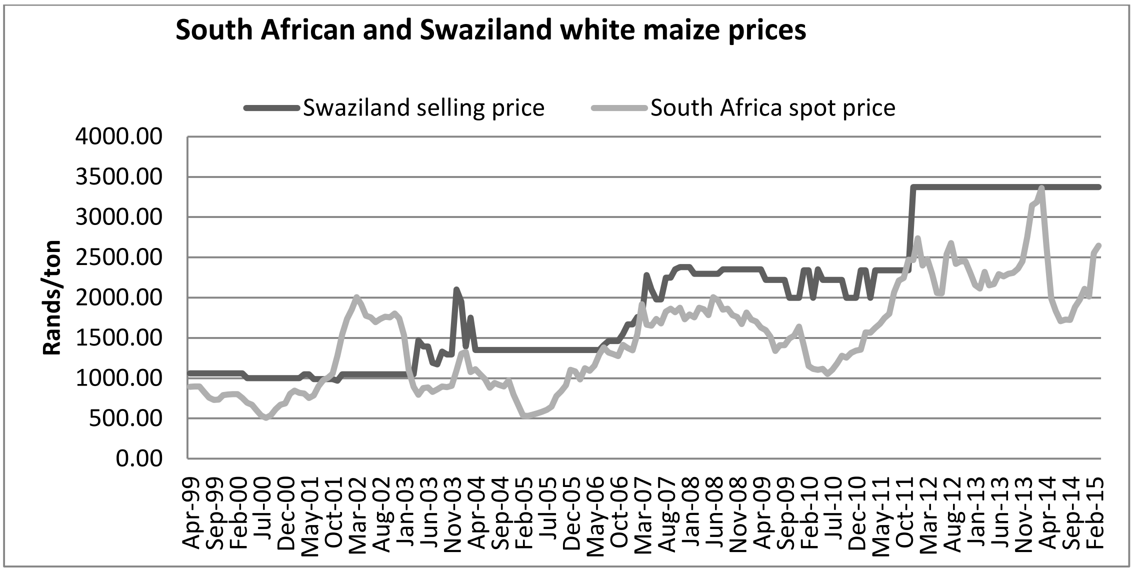

Figure 4-2: Price movements of South African and Swaziland white maize prices

There are three main reasons which explain the structure of the Swazi domestic price. Firstly, it is the pricing policy that allows prices to be set once, for the whole season, unless there are extreme weather calamities that cause severe maize shortages. Another reason for a change in prices would be when South African prices tend to be more volatile. Secondly, the government's involvement in the pricing setting, as mentioned before, which sets the domestic floor prices. This control affects prices, in that government and its bureaucracy may take time to make adjustments and respond to international price changes. Lastly, there is lack of competition in the importing of white maize. Taking into consideration the fact that Swaziland has only one importing organisation, this has a negative impact on domestic prices.

4.6.2 Summary and Statistics

The statistical properties of the variables used in the analysis are depicted in Table 4.3. It shows that domestic prices are, on average, higher than international prices. Looking at the standard deviation as a measure of volatility[2], Swaziland domestic prices are more volatile than South Africa prices are. This implies that even though Swaziland prices are set seasonally, the relative rate at which the prices change annually is high. The coefficient of

[2] Volatility is the degree of variation of a trading price series over time as measured by standard deviation.

variation also reveals that the Swaziland white maize prices are more volatile than the South African prices are, over the years.

Table 4-3: Price statistics

	Swaziland (Domestic Price)	South Africa (World price)	Import Parity Price	Diesel Prices
Mean (Rands)	1995.24	1502.11	1668.69	6.68
Standard deviation	848.25	612.94	667.26	3.27
Coefficient of variation	0.43	0.41	0.40	0.49

4.7 Conclusion

It is clear that time series methods provide convenient methods in measuring the relationship between spatially separated markets. In order to determine which time series methods are best suited for an analysis, the underlying data generating properties of the data needs to be tested. In its most basic form, time series econometrics can simply involve the estimation of a regression equation. As mentioned in chapter 2, this approach have limitations in that it does not account for dynamic adjustment that can occur between markets and results could be spurious if the univariate properties of the variables in question does not confirm stationarity. Compared with regression models, cointegration assists in the avoidance of spurious results associated with time series data. Since cointegration tests capture long run dynamics, it is important then to complement them with ECM to estimate short run dynamics between different variables. These models assist to determine if the LOOP of a particular commodity in markets separated by distance holds. A limitation of standard cointegration techniques is that they test for linear price adjustments, yet agricultural commodity markets are commonly characterised by nonlinear adjustments arising from policies and other factors. In this case, the Wald F-statistic needs to be used to test for symmetric adjustment using the positive and negative error correction term components. At this point, it is important to note that the underlying data generating process again should be used to determine which method suits the data the best. Therefore, the tests to establish this and the estimation results of the determined model will be covered in the next chapter.

The descriptive statistics in the form of graphs has shed some light on the relationship between prices in the two markets. The graphs have shown that in particular years there is a slight correspondence between domestic market prices and world/ South African prices. The descriptive statistics further reveal that Swaziland domestic prices are more volatile than South African prices, implying that the relative rate at which the prices change annually is high compared to South African price. South African spot prices have variability throughout the period under consideration. In contrast to this; Swaziland prices are constant, rising discretely in certain periods. This is a result of the pricing method where the prices are set once a year, unless there is an urgent need to change the prices, as for severe drought shocks. The failure of Swaziland's prices to respond immediately to factors that is expected to affect it proves that the white maize market is far from open. The movement of the prices in Swaziland is likely to be affected by the pricing policy, with the government setting the floor prices and the current market structure allowing for a monopoly importer.

Chapter Five

Empirical results and estimation

5.1 Introduction

This chapter lays out the empirical findings of the study. The econometric results presented here reveal the extent of market integration and price transmission. The factors that impede price transmission from the world to the domestic white maize market are also speculated on. The statistical tools used for analysis were Eviews 8 and all variables are converted into natural logs. First, univariate properties of all the variables used for analysis are determined. Then cointegration and error correction models are estimated. As mentioned previously, there are two scenarios in this study that are analysed. The first is where current maize marketing and pricing policies are considered and the other when they are relaxed. These two scenarios are considered for comparative purposes in order to gauge what the effect of the current policies might be.

5.2 Univariate properties of the data

In this subsection, the null-hypothesis of non-stationary price series is tested against the alternate that suggests a stationary series. In Table 5.1 , the results of the Augmented Dickey Fuller (ADF) stationarity test are discussed. Table 5.1 shows that all the price series are stationary when differenced, implying that they are all integrated to order one I(1). The correlograms in Appendix A also confirm stationarity of prices in first differences, such that the Autocorrelation Functions (ACF) converged fast towards zero for the differenced series. The graphical representation in Appendix A also shows that the series in levels are not mean reverting, but that they do return back to the mean when differenced. The Schwarts information criterion (SIC) was used and the lag 12 was selected based on maximum frequency data of 12 months.

Table 5-1: Unit root tests for price series

Series	ADF t-test	Probability	Order of Integration
Swaziland selling price (LY)	1.710	0.979	I(1)
Differenced Swaziland selling price (LY)	-12.773	0.000	
South African spot price (LX1)	0.431	0.806	I(1)
Differenced South	-9.097	0.000	

African spot price (ΔLX1)			
Import parity price (LX5)	0.541	0.832	I(1)
Differenced import parity price (ΔLX5)	-14.327	0.000	

5.3 Cointegration Test

After determining that the price series were stationary in differences and therefore at I(1), cointegration test were done. The cointegration or long-run relationship of prices describes the integration of spatially separated markets. The parameters estimated with cointegration methods are considered as price transmission elasticities that estimate how price signals and information cross spatially separated markets. In this study the two-step Engle-Granger cointegration method is used. This method were deemed sufficient (since we expect a uni-directional relationship from South Africa to Swaziland,it is therefore not necessary to estimate the series in a system, such as in a Vector Error Correction Model).

The hypothesis tested was:

H_0: No cointegration

H_1: Cointegration

5.3.1 Engle-Granger test for domestic (Swaziland) and world (South African) prices

Firstly, an OLS regression was run to test for a long-run relationship. The results are reported in Table 5-2 , where LY (Swaziland domestic/selling price) is the dependent variable and LX1 (South African prices) is the independent variable.

Table 5-2: OLS results for the World (South African spot price) and Swaziland selling price

Variable	Coefficient	t-Statistic	Probability
C	2.228	6.328	0.00
LX1	0.731	15.021	0.00

The coefficient of the value of variable LX1 is significant at 1 percent level, implying that South African prices influence Swaziland’s domestic white maize market. The elasticity of transmission is 0.73. This shows that a 1 percent increase (decrease) in South African white maize prices leads to 0.73 percent increase (decrease) in Swaziland’s domestic prices. Since this elasticity is not equal to 1, it seems that the LOOP cannot be confirmed. This, to a large extent confirms a priori expectations, since the current policies are expected to create market distortions which would cause the LOOP to be violated. This could also result from the non-accountability of transaction costs.

The second step in the Engle-Granger approach is to test the residual (U_t) for unit root, as depicted in Table 5-3 . The decision rule is to reject H_0 (No-cointegration) if the t-statistic is greater than the critical value in absolute terms. The t-statistic (-2.163) of the ADF is greater than the critical value (-1.943) of the Engle-Granger at a 5 percent level of significance (in absolute terms), thus we reject the null of no cointegration. This indicates that there is long-run relationship between Swaziland and South African white maize prices, thus indicating that markets are integrated.

Table 5-3: ADF test results on residual

	t-Statistic	Critical value	Probability
Residual (U_t)	-2.163	-1.943	0.030

5.3.2 Engle-Granger test for import parity (LX5) and world prices (LX1)

In terms of the second scenario where the current policies are relaxed, the import parity price as a dependent variable (LX5). The import parity prices are different from Swaziland's domestic prices in that they are not set through the marketing and pricing policies rather through market demand and supply. The cointegration results are presented in Table 5-4 . The coefficient of the value of world prices (LX1) is significant at 5 percent level, implying that South African spot prices influence the Swaziland white maize market. The magnitude of the coefficient indicates that, on average, a 1 percent increase in import parity prices causes 0.83 per cent increase in the Swaziland maize prices. As mentioned earlier, the LOOP holds if the coefficient in a linear transmission equation is equal to one. The results show a coefficient of 0.83, which is close to one, therefore, the LOOP is confirmed in the case of import parity pricing.

Table 5-4: OLS results for import parity (LX5) and Swaziland (LY) prices

Variable	Coefficient	Std. Error	t-Statistic	Probability
C	1.396	0.350	3.984	0.000
LX5	0.832	0.048	17.472	0.000

As evidenced in Table 5.5 , the ADF test statistic was compared with the critical values in order to confirm that the residuals from the long term equation are stationary. The t-stat (-2.77) is greater than the critical value (-2.57) in absolute terms, therefore we reject the null hypothesis of no cointegration. This confirms the long-run equilibrium relationship between Swaziland import parity prices and Swaziland maize prices.

Table 5-5: Residual unit root test

	t-Statistic	Critical value	Probability
Residual (U_t)	-2.77	-2.57	0.01

5.4 Error correction model (ECM)

Since it is not enough to only test for long run relationship then the ECM test should be done to determine the extent to which short-run dynamics correct deviation from the long-run equilibrium. The ECM analysis is done, with the lag selection criteria first. The world and domestic prices have a lag order 3 as suggested by the SIC. Similarly, the import parity and Swaziland domestic price have a lag order of 3.

5.4.1 ECM test for world (South African) and domestic (Swaziland) price

In this subsection, as presented in Table 5-6 an ECM was to capture the short run dynamics of world prices (South African spot prices used as a proxy) on the domestic price in Swaziland. The error correction term (ECTt-1) shows how variables move back to the estimated long-run equilibrium state, if a shock occurs. The ECTt-1 in this scenario was found to be negative and significant at 10 percent level of significance, implying that there is convergence of prices to long-run equilibrium. The error correction term shows that a shock is corrected at a speed of 3.8 per cent per period. Based on the magnitude of the error correction term the speed of adjustment to equilibrium is slow. This indicates that there is a relatively inefficient correction of shocks. Again this confirms a priori expectations, since prices are not frequently adjusted through the season. This serves as evidence of the inefficiency caused by the marketing and pricing policy of Swaziland.

Table 5-6: Error correction model-world (LX1) and domestic price (LY)

Variable	ECM Coefficient	Std. Error
C	0.001*	0.006
D(LX1)	-0.020	0.067
D(LX1(-1))	0.111	0.072
D(LX1(-2))	-0.135*	0.072
D(LX1(-3))	-0.001	0.067
D(LY(-1))	-0.234***	0.078
D(LY(-2))	-0.220***	0.078
D(LY(-3))	0.081	0.077
ECT_{t-1}	-0.039*	0.021

The significant coefficients of the lagged differenced terms suggest that a there is slow transmission of South African price shocks to the Swazi market, suggesting a weak linkage of the markets in the short run. The short-run effect of a change in the South African prices on Swaziland price is -0.020, is not significant from zero. This indicates that changes in South African prices from a prior period do not explain Swaziland prices in the short-run well. However, if we consider further prior periods, such as D(X1(-2)), the short-run coefficient -0.135 is significantly different from zero. This implies that when one considers more distant periods in the past, changes to the South African white maize prices have a significant relationship with Swaziland's domestic prices in the short-run. The lagged differenced coefficients of Swaziland prices are significant at different levels, implying that prior domestic prices explain well current prices in the short-run.

5.4.2 ECM test for import parity (LX5) and Swaziland (LY) domestic price

In terms of considering the second scenario, the ECM model captures the short-run adjustment of changes in price spread. As indicated in Table 5-7 the results show that the short-run effect of the change in South African price on Swaziland import parity prices is 0.871 percent. The short-run effect is significantly different from zero, meaning that Swaziland respond to changes in prices in the short-run.

As further revealed in Table 5-7, the differenced and lagged differenced coefficients of Swaziland domestic (LY)) are significantly different from zero, meaning that prior domestic prices influence current Swaziland maize prices.

The coefficient of the error correction term is significant at 5 percent and has an expected negative sign. The error term coefficient is -0.047 meaning that there is slow adjustment of around 4.7 percent per period once a shock occurs. Thus, complete elimination of marketing and pricing policies could improve the extent of market integration or price transmission in that price signals are transmitted much more efficiently.

Table 5-7: Showing results of an error correction model – import parity (LX5) and Swaziland domestic price (LY)

Variable	ECM Coefficient	Std. Error
C	0.01*	0.006
D(LX5)	0.027	0.057
D(LX5 (-1))	0.038	0.057
D(LX5 (-2))	-0.074	0.058
D(LX5 (-3))	-0.045	0.057
D(LY(-1))	-0.249***	0.078
D(LY(-2))	-0.203***	0.078
D(LY(-3))	0.063	0.077
ECT_{t-1}	-0.047**	0.023

* Statistical significance at the 10 per cent level.
** Statistical significance at the 5 per cent level.
*** Statistical significance at the 1 per cent level.

5.5 Symmetric Test

In order to examine whether price transmission between South Africa and Swaziland white maize market is symmetric, the coefficients of negative and positive error term should not be statistical significantly different, otherwise there would be asymmetric adjustment. In this study asymmetric adjustment may result from the maize marketing, pricing and trade policies, and transaction costs. Such factors could influence how price decreases and increases in the South African white maize market are transmitted to the Swaziland maize market. The null hypothesis of symmetry is tested with a Wald F-statistic. The error term coefficients are estimated in the AECM, where the error correction term is split into positive and negative, such that ECT_{t-1}^- and ECT_{t-1}^+. The lag selection criterion suggests a lag order 3 for both scenarios.

5.5.1 Symmetric test in the South African (LX1) and Swaziland (LY) white maize price

As revealed in Table 5-8, Wald F-Statistic failed to reject the null hypothesis of symmetry at conventional levels of statistical significance, thus implying symmetric adjustment between South African and Swaziland prices. This is however very close to the 10 percent level of significance, and as a result of the strong possibility of asymmetric adjustment created by the current policy structure it was opted to further explore and evaluate of asymmetry in the adjustment process.

Table 5-8: The Wald Test of Swaziland domestic and South African prices

Test Statistic	Value	Probability
t-statistic	1.602	0.111
F-statistic	2.566	0.111

The estimated results in Table 5-9 indicate that Swaziland selling prices respond only to positive shocks, implying that economic agents in the Swaziland maize sector do not benefit from lower world prices. As revealed in Table 5-9, the coefficient of ECT_{t-1}^{+} is negative and significant at 5 percent level, while the coefficient of ECT_{t-1}^{-} is insignificant and very small. The estimation results reveal that about 11.1 percent of deviation from equilibrium level is corrected per period for positive shocks.

Table 5-9: AECM of Swaziland domestic (LX1) and South African (LY) prices

Variable	**Coefficient**	**Std. Error**
C	0.021**	0.009
D(LX1)	-0.013	0.067
D(LX1(-1))	0.103	0.072
D(LX1(-2))	-0.146**	0.072
D(LX1(-3))	-0.016	0.068
D(LY(-1))	-0.222***	0.078
D(LY(-2))	-0.218***	0.078
D(LY(-3))	0.083	0.077
$(ECT_{t-1})^{-}$	-0.005	0.029
$(ECT_{t-1})^{+}$	-0.111**	0.050

* Statistical significance at the 10 per cent level.
** Statistical significance at the 5 per cent level.
*** Statistical significance at the 1 per cent level.

5.5.2 Symmetric test between Swaziland import parity (LX5) and Swaziland domestic white maize (LY) prices

As revealed in Table 5-10, the F-statistic from the Wald test is significant at 5 percent level; therefore, the null hypothesis of symmetry in the South African and Swaziland import parity prices is rejected. This implies that there is a non-linear or asymmetric transmission of Swaziland domestic prices and import parity prices, indicating inefficient price transmission. This means the Swaziland's import parity price reaction to South African price decrease is different than increases.

Table 5-10: The Wald Test of Swaziland import parity and South African prices

Test statistic	Value	Probability
t-statistic	-2.19	0.03
F-statistic	4.80	0.03

The estimated results from the AECM indicate that Swaziland's domestic prices respond only to positive shocks. As indicated in Table 5-11, the coefficient of ECT_{t-1}^{-} is insignificant at all levels. While the ECT_{t-1}^{+} is negative and significant at 1 percent level. The estimation results prove that about 16.5 percent of deviation from equilibrium level is corrected per period, for all positive shocks.

Table 5-11: AECM of Swaziland import parity and South African prices

Variable	Coefficient	Standard Error
C	0.025***	0.009
D(LX5)	0.031	0.056
D(LX5(-1))	0.022	0.057
D(LX5(-2))	-0.094	0.058
D(LX5(-3))	-0.063	0.057
D(LY(-1))	-0.215***	0.078
D(LY(-2))	-0.192***	0.077
D(LY(-3))	0.072	0.076
ECT_{t-1}^{+}	-0.165***	0.059
ECT_{t-1}^{-}	-0.001	0.031

* Statistical significance at the 10 per cent level.

** Statistical significance at the 5 per cent level.

*** Statistical significance at the 1 per cent level.

5.6 Conclusion

The unit root test proved that all the data series, used in the analysis of price transmission are stationary and I(1). The Engle-Granger test for cointegration confirmed the existence of a long-run relationship between South African and Swaziland white maize prices in the presence of government policies, and also when they are removed (free trade). A symmetric ECM for both scenarios were estimated to measure the short run dynamics between Swaziland and South Africa. It revealed that the speed of correction or adjustment to equilibrium of is much slower under current market policies. This provides initial evidence of inefficient price transmission and strong possibilities for the inefficient allocation of resources in the white maize sector in Swaziland. In order to examine whether price transmission between South Africa and Swaziland white maize market is symmetric, the coefficients of negative and positive error term should not be statistical significantly different, otherwise there would be asymmetric adjustment.

In order to investigate the possibility of asymmetric price adjustment between Swaziland and South Africa the Wald F-test was performed to test the null hypothesis of symmetric adjustment. In the presence of maize marketing and pricing policies, the test failed to reject the null hypothesis of symmetry at conventional levels of statistical significance, albeit very close to the 10 percent level of significance. However, the error correction term results from the AECM proved that Swaziland selling prices respond only to positive shocks to the difference between South African and Swaziland prices. This implied that economic agents in the Swaziland maize sector therefore do not benefit from higher South African prices. In the removal of policies, the null hypothesis of symmetry was rejected. Here it showed that Swaziland domestic prices respond significantly to positive shocks in the difference between Swaziland import parity prices and Swaziland domestic prices but not to negative shocks.

Chapter Six
Summary and Conclusion

6.1 Introduction

This chapter lays out a summary of the study on the integration of the two spatially separated markets and draws some conclusions based on the results generated. It also presents recommendations to policy makers and white maize industry stakeholders in Swaziland.

6.2 Summary of the study

The study analysed market integration and price transmission between Swaziland and South Africa, in the presence of the current maize marketing policy. This was compared with a scenario where these policies were relaxed (free trade or open economy). In order to understand what methods are commonly used in such an analyses, literature on spatial price transmission and market integration between world and domestic prices were reviewed. In order to relate the findings of the literature study to the case of Swaziland a comprehensive overview of how marketing policies evolved was and how the market functions was given in Chapter 3. Lastly, we tested for the extent of price transmission between the world and domestic prices, considering the two scenarios mentioned above.

The literature study revealed that price transmission is described as the extent to which prices are transferred between markets in free trade. In the case of free trade, the transmission of prices is expected to adhere to the LOOP, which postulates the equalisation of prices between markets. This study aimed to find out if the LOOP holds and if there is long-run transmission of South African and Swaziland white maize prices. The study also aimed to determine the short run dynamics between the markets. South Africa was chosen on the basis that for the past five years, Swaziland has been buying commercial maize only from South Africa. It is therefore expected that the South African maize market presents the best possible link and proxy to world maize markets.

The maize marketing policy in Swaziland controls flow of maize imports and domestic marketing and is implemented by the NMC. The NMC is Swaziland's monopoly white maize importer and is also responsible for the stabilisation of domestic prices. The organisation conforms to the maize pricing policy for price formation. Although Swaziland white maize domestic prices may be determined by supply and demand factors, such as inflation, white maize world prices, and climatic variations, the government and NMC make the final decision. The buying price is negotiated by the price setting committee, and then gazetted in the parliament. The selling price is set by NMC, with the assistance of the Ministry of Finance. Mark-up pricing and previous South African prices are used as reference prices to set Swaziland's selling price, while considering other factors such as production costs. Thus, there is no fixed formula used in the adjustment of the prices. Swaziland white maize prices are stable, though substantially higher than those in the world market are. The higher domestic prices are associated to domestic protection (maize marketing and pricing) policies that support local production. Production trends prove that Swaziland self-sufficiency is not reached despite the presence of these policies.

The study conducted an analysis of spatial price transmission of the South African prices to Swaziland in the presence of the strict maize marketing policy, and without the policy. A cointegration technique was utilised to investigate if prices in the Swazi and South African white maize markets co-move. Using the Engle-Granger cointegration technique the null hypothesis of no cointegration relationship was rejected in both scenarios. This means that there is a co-movement between Swaziland and South African white maize prices when domestic policies are considered and without it. It is estimated that on average, in the long run, a 1 percent increase in South African white maize prices leads to 0.83 percent increase in Swaziland selling prices in presence of marketing and pricing policies. On the other hand, when policies are eliminated, it was evidenced that on average, a 1 percent increase in South African white maize prices changes by 0.96 per cent of Swaziland selling prices. This proves that the rate at which white maize South African prices are transmitted to Swaziland domestic prices in the presence of marketing and pricing policy is much smaller than that when policies are not considered.

Since the long-run relationship/market integration was confirmed, short run dynamics between the two markets were also estimated. The results showed that in the presence of policies the ECT_{t-1} was found to be negative and significantly different from zero, when the domestic policies are considered. The error correction term corrects or adjusts the disequilibrium of the system at a speed of 3.8 percent per period, proving a slow speed of adjustment to equilibrium. It is expected that this is caused, at least in part, by the maize marketing and pricing policies. Compared to domestic prices without policy intervention the speed of adjustment to equilibrium is low. Without policy intervention approximately 4.7 percent of the divergence from the long-run equilibrium is corrected per period. Though the difference between the two scenario's is smaller, this could therefore serve as initial evidence that the government policies could be responsible for the lack of efficient market integration. The study also revealed that complex short-run dynamics in the Swaziland white maize price suggesting industry specific factors were also important in domestic price dynamics in both scenarios.

Factors such as maize marketing and pricing policies, and transaction costs could be responsible for nonlinear adjustments. Therefore, the Wald F-Statistic was tested in both scenarios, when policies were present and when eliminated. In the presence of maize marketing and pricing policies there was symmetric transmission of prices between the South African and the Swaziland market. The F-statistic revealed a probability of 0.11 which is statistically insignificant conventional levels, yet very close to a significance level of 10 percent. As a result the short run dynamics was still explored. The error-correction term proved that Swaziland domestic prices respond only to price decreases. The coefficient of positive error correction term is negative and highly significant at 5 percent level, while the coefficient of negative error correction term is insignificant and very small. The estimation results reveal that about 11.1 percent of deviation above equilibrium level is corrected per period.

There is asymmetric transmission of prices between the import parity prices and Swaziland white maize market when policies are in existence. The null hypothesis of symmetry was rejected at 5 per cent level of statistical significance. The AECM proved that the negative error correction term is insignificant at all levels, while the positive error correction term is negative and highly significant at 5 percent level. The positive error correction suggests that 16.5 percent of deviation above equilibrium level is corrected per period, indicating that Swaziland's import parity prices respond quickly only to price decreases.

In conclusion, the study confirms that the hypothesis stating that current (maize marketing and pricing) policies are not hampering marketing integration and impeding regional price signals from flowing through to Swazi markets is rejected. The maize marketing and pricing policy of Swaziland's white maize market reduce both efficiency and integration with international markets in particular the South African market. However, when the policies are removed creating free trade or open market, the market will determine the prices; such that, if wholesale world prices (South African) fall, then domestic prices will decrease, thus causing higher surplus for importers. Price formation in Swaziland's maize market would conform to demand and supply and the import parity price, creating prices market prices that are satisfy all market actors.

6.3 Recommendations

Swaziland’s domestic prices are high compared to regional levels, twice as high as South Africa’s which it shares borders with. This could be caused by the pricing and maize marketing policies responsible for price setting in the Swaziland’s white maize market. Research conducted here suggests that these policies could be responsible, at least in part, for the poor response of domestic prices to the world prices. A more liberal policy dispensation that allows for free trade and price movement could possible lead to lower prices which would benefit consumers and support food affordability and security. This could however be at the expense of producers, who would not receive price support or protection. Ultimately this boils down to a trade-off between self-sufficiency or food affordability.

6.4 Suggestions for future research

This study on focused on price transmission and market integration and the efficiency related to this. If one however wants to fully quantify the effect of the current marketing policy on the different agents in the white maize value chain, a full welfare assessment needs to be done. This would imply estimating welfare effects related to the price transmission processes determined here and is recommended for future research. This study therefore could potentially serve as a starting point for determining the welfare implications on consumers, producers and the Swazi population in general of the policies that are currently prevailing.

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Appendices

Appendix A: Data series graphs and correlograms for unit root test

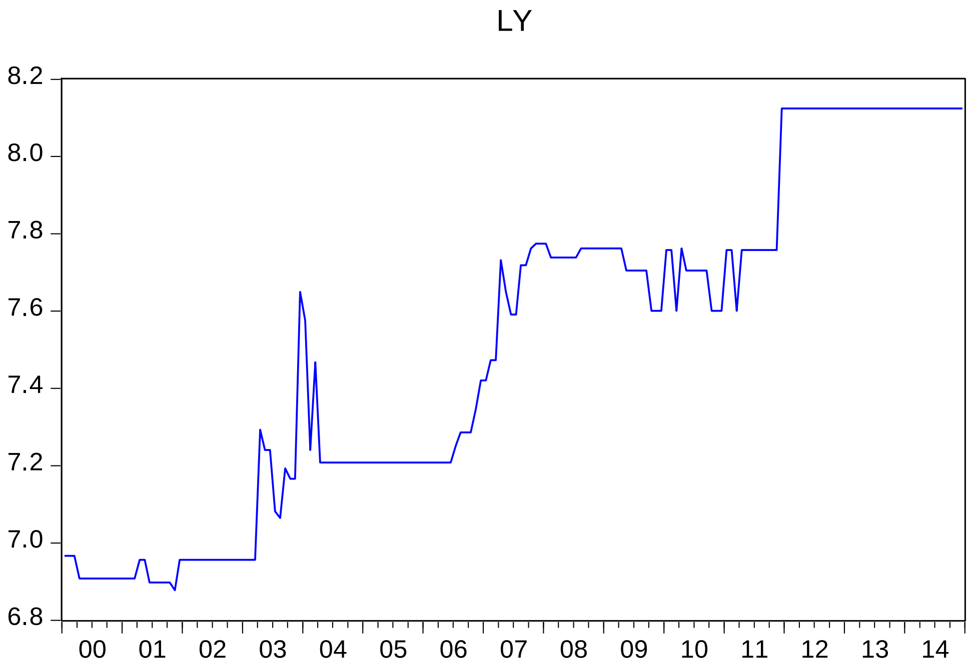


Figure A. 1: Graph showing non-stationary Swaziland maize prices graph (LY) at I(0)

Date: 05/10/16 Time: 13:33
Sample: 2000M01 2014M12
Included observations: 180

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.|*******</td><td>.|*******</td><td>1</td><td>0.974</td><td>0.974</td><td>173.57</td><td>0.000</td></tr>
<tr><td>.|*******</td><td>.|* |</td><td>2</td><td>0.955</td><td>0.125</td><td>341.36</td><td>0.000</td></tr>
<tr><td>.|*******</td><td>.|* |</td><td>3</td><td>0.941</td><td>0.103</td><td>505.09</td><td>0.000</td></tr>
<tr><td>.|*******</td><td>*|. |</td><td>4</td><td>0.921</td><td>-0.089</td><td>662.89</td><td>0.000</td></tr>
<tr><td>.|*******</td><td>.|. |</td><td>5</td><td>0.904</td><td>0.036</td><td>815.91</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>6</td><td>0.888</td><td>0.003</td><td>964.44</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>7</td><td>0.873</td><td>0.018</td><td>1108.6</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>8</td><td>0.856</td><td>-0.020</td><td>1248.3</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>*|. |</td><td>9</td><td>0.834</td><td>-0.130</td><td>1381.6</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>10</td><td>0.812</td><td>-0.052</td><td>1508.7</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>11</td><td>0.794</td><td>0.050</td><td>1630.9</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>12</td><td>0.773</td><td>-0.036</td><td>1747.3</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>13</td><td>0.751</td><td>-0.023</td><td>1858.1</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>14</td><td>0.731</td><td>-0.032</td><td>1963.5</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>15</td><td>0.712</td><td>0.037</td><td>2064.1</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>16</td><td>0.694</td><td>0.017</td><td>2160.3</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>17</td><td>0.674</td><td>-0.003</td><td>2251.7</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>18</td><td>0.654</td><td>-0.049</td><td>2338.1</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>19</td><td>0.634</td><td>-0.027</td><td>2419.8</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>20</td><td>0.615</td><td>0.020</td><td>2497.1</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>21</td><td>0.594</td><td>-0.023</td><td>2569.8</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>22</td><td>0.575</td><td>0.007</td><td>2638.3</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>23</td><td>0.556</td><td>-0.025</td><td>2702.8</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>24</td><td>0.537</td><td>-0.010</td><td>2763.3</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>25</td><td>0.516</td><td>-0.042</td><td>2819.5</td><td>0.000</td></tr>
</table>

.|****		.|.		26	0.496	-0.003	2871.8	0.000
.|***		.|.		27	0.478	0.030	2920.7	0.000
.|***		.|.		28	0.460	-0.004	2966.4	0.000
.|***		.|.		29	0.443	0.011	3008.9	0.000
.|***		.|.		30	0.424	-0.031	3048.2	0.000
.|***		.|.		31	0.408	0.027	3084.9	0.000
.|***		.|.		32	0.394	0.031	3119.2	0.000
.|***		.|.		33	0.377	-0.025	3150.9	0.000
.|***		.|.		34	0.360	-0.036	3180.0	0.000
.|**		.|.		35	0.344	-0.012	3206.8	0.000
.|**		.|.		36	0.329	0.006	3231.3	0.000

Figure A. 2: Swaziland maize prices showing non-stationary correlogram at I(0)

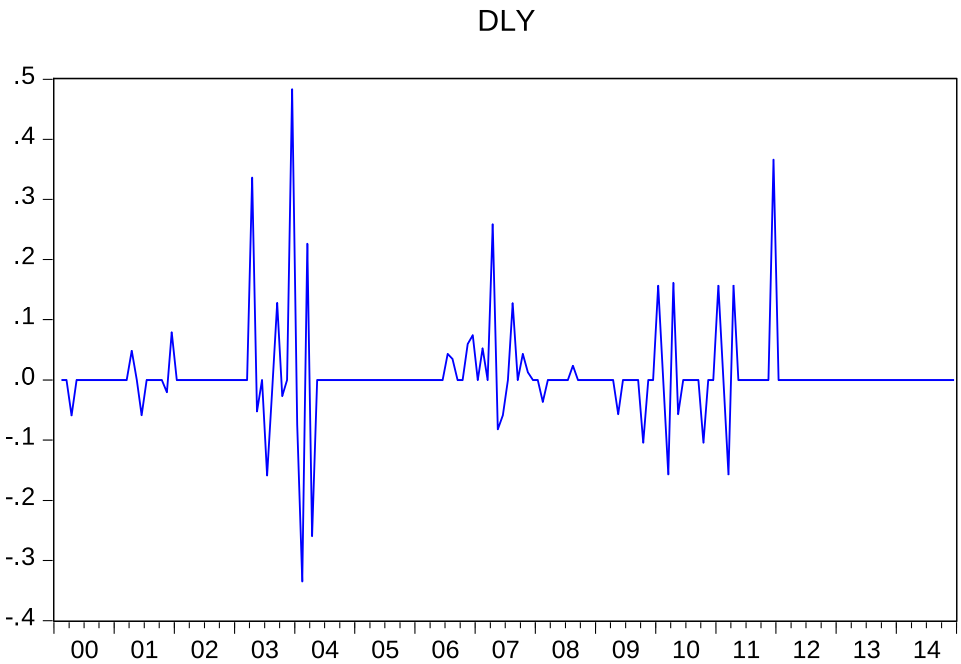


Figure A. 3: Graph showing Swaziland maize prices (LY) at I(1)

Date: 05/10/16 Time: 13:35
Sample: 2000M01 2014M12
Included observations: 179

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
**|.		**|.		1	-0.230	-0.230	9.6571	0.002
*|.		**|.		2	-0.157	-0.222	14.176	0.001
.|*		.|.		3	0.137	0.046	17.620	0.001
*|.		*|.		4	-0.107	-0.102	19.726	0.001
.|.		.|.		5	-0.032	-0.056	19.917	0.001
.|.		*|.		6	-0.014	-0.089	19.952	0.003
.|.		.|.		7	0.006	-0.022	19.958	0.006
.|*		.|*		8	0.182	0.179	26.233	0.001
.|.		.|*		9	-0.004	0.103	26.236	0.002
*|.		*|.		10	-0.142	-0.073	30.085	0.001
.|*		.|.		11	0.091	0.021	31.682	0.001
.|.		.|.		12	-0.003	0.020	31.684	0.002
.|.		.|.		13	-0.026	0.052	31.815	0.003
*|.		*|.		14	-0.069	-0.089	32.741	0.003
.|.		.|.		15	0.000	-0.064	32.741	0.005

.|. |	*|. |	16	0.024	-0.067	32.853	0.008
.|. |	.|. |	17	0.006	0.004	32.860	0.012
.|. |	.|. |	18	-0.023	-0.000	32.969	0.017
.|. |	*|. |	19	-0.046	-0.090	33.396	0.022
.|. |	.|. |	20	0.045	-0.031	33.812	0.027
.|. |	.|. |	21	-0.059	-0.064	34.534	0.032
.|. |	.|. |	22	-0.023	-0.004	34.645	0.042
.|. |	.|. |	23	0.038	0.015	34.940	0.053
.|. |	.|. |	24	0.044	0.047	35.352	0.063
.|. |	.|. |	25	-0.024	-0.001	35.474	0.080
*|. |	*|. |	26	-0.085	-0.090	37.016	0.075
.|. |	.|. |	27	-0.004	-0.041	37.019	0.095
.|. |	*|. |	28	-0.027	-0.075	37.171	0.115
.|. |	.|. |	29	0.018	0.001	37.244	0.140
*|. |	*|. |	30	-0.073	-0.110	38.405	0.140
.|. |	*|. |	31	-0.055	-0.169	39.056	0.152
.|. |	*|. |	32	0.052	-0.090	39.652	0.166
.|. |	.|. |	33	0.010	-0.019	39.674	0.197
.|. |	.|. |	34	-0.052	-0.021	40.280	0.212
.|. |	*|. |	35	-0.014	-0.088	40.322	0.247
.|. |	*|. |	36	-0.053	-0.161	40.951	0.262

Figure A. 4: Showing Swaziland maize prices correlogram (LY) at I(1)

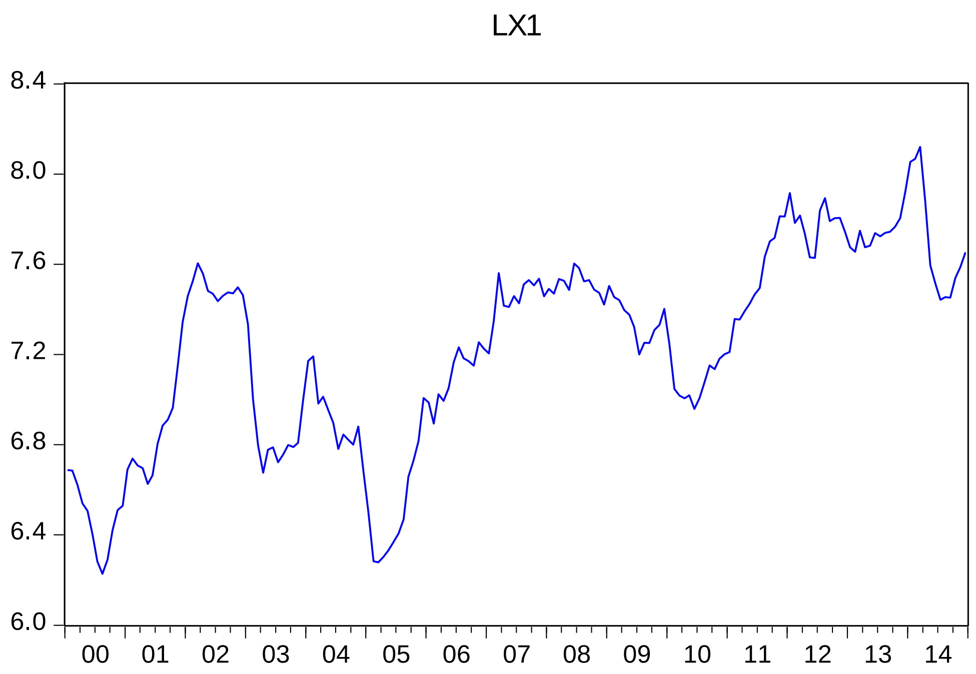


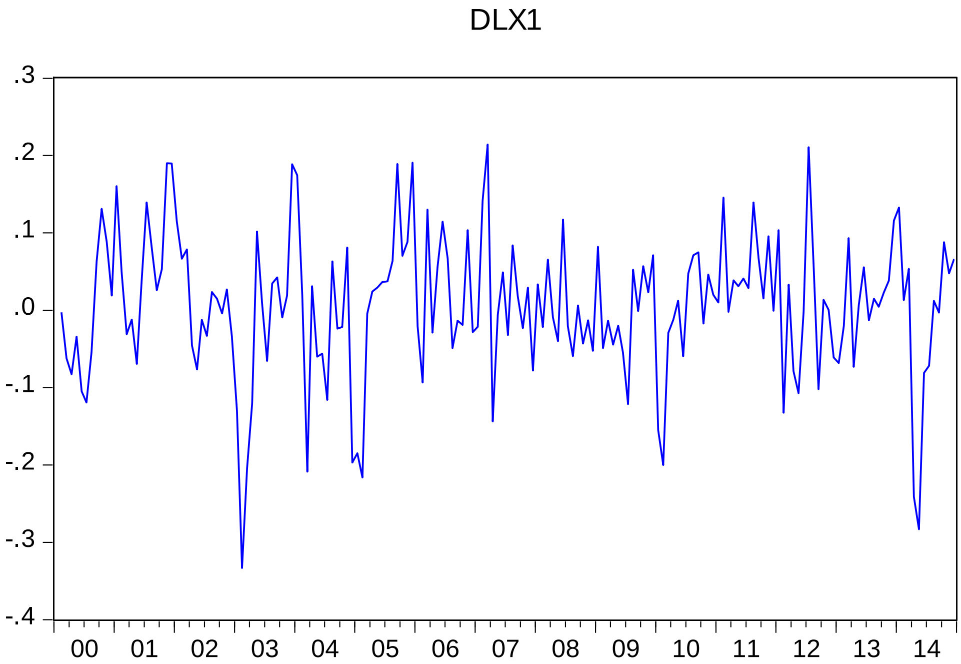
Figure A. 5: Graph showing non- stationary South African maize prices (LX1)

Date: 05/10/16 Time: 13:40
Sample: 2000M01 2014M12
Included observations: 180

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******	.|*******	1	0.971	0.971	172.73	0.000
.|*******	**|. |	2	0.928	-0.279	331.26	0.000
.|******|	.|. |	3	0.879	-0.052	474.40	0.000
.|******|	.|. |	4	0.828	-0.049	602.00	0.000
.|******|	.|. |	5	0.776	-0.018	714.70	0.000

<table>
<tr><td>.|***** |</td><td>.|. |</td><td>6</td><td>0.727</td><td>0.036</td><td>814.22</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>7</td><td>0.680</td><td>-0.021</td><td>901.84</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>*|. |</td><td>8</td><td>0.630</td><td>-0.104</td><td>977.53</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>*|. |</td><td>9</td><td>0.577</td><td>-0.073</td><td>1041.3</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>10</td><td>0.522</td><td>-0.043</td><td>1093.8</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|. |</td><td>11</td><td>0.470</td><td>0.065</td><td>1136.6</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>*|. |</td><td>12</td><td>0.419</td><td>-0.072</td><td>1170.8</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|* |</td><td>13</td><td>0.373</td><td>0.087</td><td>1198.2</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>14</td><td>0.336</td><td>0.045</td><td>1220.4</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>15</td><td>0.300</td><td>-0.062</td><td>1238.4</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>16</td><td>0.267</td><td>0.015</td><td>1252.6</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>17</td><td>0.236</td><td>-0.022</td><td>1263.8</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>18</td><td>0.207</td><td>0.019</td><td>1272.5</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>19</td><td>0.184</td><td>0.072</td><td>1279.3</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>20</td><td>0.168</td><td>0.061</td><td>1285.1</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>21</td><td>0.155</td><td>-0.041</td><td>1290.0</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>22</td><td>0.144</td><td>-0.011</td><td>1294.4</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>23</td><td>0.134</td><td>-0.034</td><td>1298.1</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>*|. |</td><td>24</td><td>0.120</td><td>-0.086</td><td>1301.1</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>25</td><td>0.101</td><td>-0.043</td><td>1303.3</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>26</td><td>0.084</td><td>0.045</td><td>1304.8</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>27</td><td>0.069</td><td>0.000</td><td>1305.8</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>28</td><td>0.053</td><td>-0.056</td><td>1306.4</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>29</td><td>0.039</td><td>0.013</td><td>1306.7</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|* |</td><td>30</td><td>0.030</td><td>0.086</td><td>1306.9</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>31</td><td>0.027</td><td>0.059</td><td>1307.1</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>32</td><td>0.025</td><td>-0.002</td><td>1307.2</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|* |</td><td>33</td><td>0.027</td><td>0.092</td><td>1307.4</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>34</td><td>0.029</td><td>-0.069</td><td>1307.6</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>35</td><td>0.030</td><td>-0.016</td><td>1307.8</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>36</td><td>0.030</td><td>0.001</td><td>1308.0</td><td>0.000</td></tr>
</table>

Figure A. 6: Showing South African (LX1) maize prices at I(1)



Date: 05/10/16 Time: 13:42

Sample: 2000M01 2014M12
Included observations: 179

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*** |	.|*** |	1	0.358	0.358	23.368	0.000
.|* |	.|. |	2	0.109	-0.022	25.562	0.000
.|. |	.|. |	3	0.058	0.029	26.173	0.000
.|. |	.|. |	4	-0.003	-0.036	26.175	0.000
*|. |	*|. |	5	-0.112	-0.116	28.512	0.000
*|. |	.|. |	6	-0.113	-0.039	30.898	0.000
.|. |	.|* |	7	0.022	0.099	30.989	0.000
.|. |	.|. |	8	0.016	-0.013	31.038	0.000
.|. |	.|. |	9	0.018	0.017	31.100	0.000
.|. |	*|. |	10	-0.049	-0.091	31.565	0.000
.|. |	.|. |	11	0.010	0.043	31.584	0.001
.|. |	*|. |	12	-0.059	-0.078	32.266	0.001
*|. |	*|. |	13	-0.132	-0.082	35.659	0.001
.|. |	.|. |	14	-0.050	0.036	36.147	0.001
.|. |	.|. |	15	-0.058	-0.060	36.813	0.001
.|. |	.|. |	16	-0.060	-0.029	37.538	0.002
.|. |	.|. |	17	-0.051	-0.016	38.056	0.002
*|. |	*|. |	18	-0.084	-0.109	39.464	0.002
*|. |	*|. |	19	-0.131	-0.088	42.922	0.001
.|. |	.|. |	20	-0.060	0.026	43.649	0.002
*|. |	*|. |	21	-0.071	-0.066	44.675	0.002
.|* |	.|* |	22	0.096	0.173	46.576	0.002
.|* |	.|. |	23	0.158	0.060	51.766	0.001
.|* |	.|. |	24	0.101	-0.010	53.902	0.000
.|. |	*|. |	25	-0.009	-0.106	53.917	0.001
.|. |	.|. |	26	-0.023	-0.022	54.026	0.001
.|. |	.|. |	27	-0.004	0.033	54.029	0.002
*|. |	*|. |	28	-0.096	-0.071	55.999	0.001
*|. |	*|. |	29	-0.128	-0.093	59.558	0.001
*|. |	.|. |	30	-0.077	-0.020	60.846	0.001
.|. |	.|. |	31	0.003	-0.029	60.847	0.001
*|. |	*|. |	32	-0.133	-0.169	64.762	0.001
.|. |	.|. |	33	-0.029	0.074	64.949	0.001
.|. |	.|. |	34	0.046	-0.014	65.419	0.001
.|. |	*|. |	35	-0.041	-0.066	65.804	0.001
*|. |	.|. |	36	-0.068	-0.021	66.858	0.001

Figure A. 7: Correlogram showing South African maize prices at I(1)

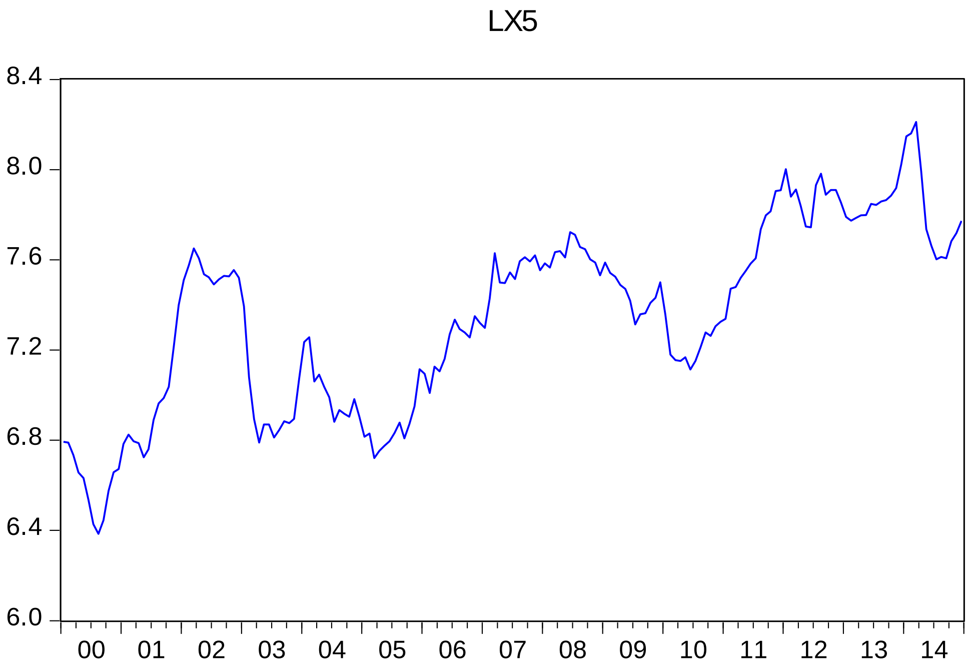


Figure A. 8: Graph showing stationary import parity price (LX5) at I(0)

Date: 12/30/16 Time: 18:45
Sample: 2000M01 2014M12
Included observations: 180

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.|*******</td><td>.|*******</td><td>1</td><td>0.973</td><td>0.973</td><td>173.26</td><td>0.000</td></tr>
<tr><td>.|*******</td><td>**|. |</td><td>2</td><td>0.934</td><td>-0.241</td><td>333.74</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>3</td><td>0.891</td><td>-0.048</td><td>480.56</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>4</td><td>0.846</td><td>-0.037</td><td>613.67</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>5</td><td>0.800</td><td>-0.023</td><td>733.51</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>6</td><td>0.757</td><td>0.019</td><td>841.29</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>7</td><td>0.715</td><td>-0.015</td><td>937.96</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>*|. |</td><td>8</td><td>0.670</td><td>-0.089</td><td>1023.4</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>*|. |</td><td>9</td><td>0.620</td><td>-0.102</td><td>1097.1</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>10</td><td>0.569</td><td>-0.037</td><td>1159.4</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>11</td><td>0.521</td><td>0.065</td><td>1211.9</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|. |</td><td>12</td><td>0.472</td><td>-0.063</td><td>1255.5</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|* |</td><td>13</td><td>0.430</td><td>0.079</td><td>1291.7</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|. |</td><td>14</td><td>0.393</td><td>0.019</td><td>1322.1</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|. |</td><td>15</td><td>0.357</td><td>-0.044</td><td>1347.4</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>16</td><td>0.322</td><td>-0.000</td><td>1368.2</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>17</td><td>0.288</td><td>-0.035</td><td>1384.8</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>18</td><td>0.256</td><td>0.027</td><td>1398.1</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>19</td><td>0.229</td><td>0.070</td><td>1408.7</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>20</td><td>0.210</td><td>0.072</td><td>1417.8</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>21</td><td>0.195</td><td>-0.002</td><td>1425.6</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>22</td><td>0.186</td><td>0.037</td><td>1432.8</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>23</td><td>0.179</td><td>-0.009</td><td>1439.5</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>24</td><td>0.171</td><td>-0.035</td><td>1445.7</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>25</td><td>0.162</td><td>-0.019</td><td>1451.3</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>26</td><td>0.152</td><td>-0.032</td><td>1456.2</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>27</td><td>0.142</td><td>0.004</td><td>1460.5</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>28</td><td>0.132</td><td>-0.058</td><td>1464.2</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>29</td><td>0.123</td><td>0.038</td><td>1467.5</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>30</td><td>0.120</td><td>0.065</td><td>1470.7</td><td>0.000</td></tr>
</table>

.|* |	.|. |	31	0.121	0.036	1473.9	0.000
.|* |	.|. |	32	0.119	-0.038	1477.0	0.000
.|* |	.|* |	33	0.121	0.091	1480.3	0.000
.|* |	.|. |	34	0.124	-0.020	1483.7	0.000
.|* |	.|. |	35	0.125	0.001	1487.3	0.000
.|* |	.|. |	36	0.125	-0.055	1490.8	0.000

Figure A. 9: Correlogram showing stationary import parity price at I(0)

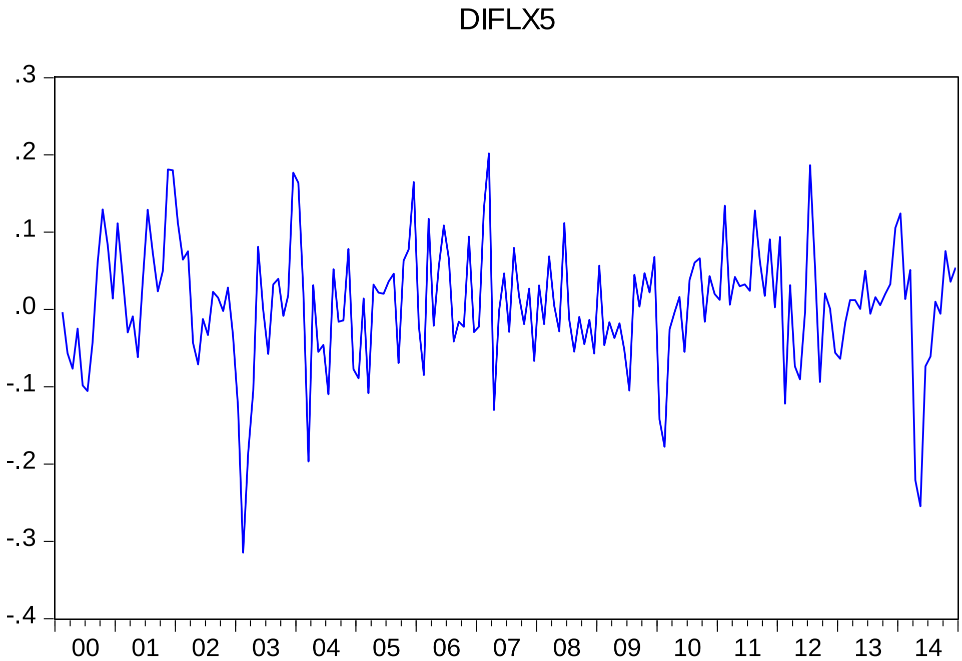


Figure A. 10: Graph showing stationary import parity prices at I(1)

Date: 12/30/16 Time: 18:52
Sample: 2000M01 2014M12
Included observations: 179

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|** |	.|** |	1	0.335	0.335	20.375	0.000
.|* |	.|. |	2	0.088	-0.027	21.780	0.000
.|. |	.|. |	3	0.035	0.016	22.011	0.000
.|. |	.|. |	4	-0.004	-0.021	22.014	0.000
*|. |	*|. |	5	-0.102	-0.107	23.969	0.000
*|. |	.|. |	6	-0.116	-0.054	26.473	0.000
.|. |	.|* |	7	0.015	0.087	26.514	0.000
.|. |	.|. |	8	0.052	0.032	27.028	0.001
.|. |	.|. |	9	0.029	0.001	27.192	0.001
.|. |	*|. |	10	-0.048	-0.082	27.640	0.002
.|. |	.|. |	11	0.010	0.036	27.661	0.004
.|. |	*|. |	12	-0.054	-0.075	28.235	0.005
*|. |	.|. |	13	-0.085	-0.029	29.643	0.005
.|. |	.|. |	14	-0.049	0.005	30.108	0.007
.|. |	.|. |	15	-0.037	-0.034	30.381	0.011
.|. |	.|. |	16	-0.028	-0.018	30.543	0.015
.|. |	.|. |	17	-0.048	-0.036	31.010	0.020
*|. |	*|. |	18	-0.095	-0.097	32.832	0.017

```
       *|.     |          *|.     |      19  -0.143  -0.102   36.951   0.008
       *|.     |          .|.     |      20  -0.109  -0.035   39.393   0.006
       *|.     |          *|.     |      21  -0.126  -0.078   42.654   0.003
       .|.     |          .|*     |      22   0.038   0.116   42.951   0.005
       .|*     |          .|.     |      23   0.094   0.042   44.801   0.004
       .|.     |          .|.     |      24   0.056  -0.025   45.463   0.005
       .|.     |          .|.     |      25   0.054   0.003   46.074   0.006
       .|.     |          .|.     |      26   0.003  -0.048   46.075   0.009
       .|.     |          .|.     |      27   0.016   0.035   46.129   0.012
       *|.     |          *|.     |      28  -0.137  -0.144   50.154   0.006
       *|.     |          .|.     |      29  -0.119  -0.034   53.210   0.004
       .|.     |          .|.     |      30  -0.046  -0.006   53.675   0.005
       .|.     |          .|.     |      31   0.058   0.047   54.399   0.006
       *|.     |          *|.     |      32  -0.120  -0.202   57.586   0.004
       .|.     |          .|.     |      33  -0.038   0.023   57.903   0.005
       .|.     |          .|.     |      34   0.036  -0.020   58.189   0.006
       .|.     |          .|.     |      35   0.004  -0.005   58.193   0.008
       *|.     |          *|.     |      36  -0.075  -0.086   59.469   0.008
```

Figure A. 11: Correlogram showing stationary import parity at I(1)

Table A- 1: Non-stationary Swaziland prices (LY) at I(0)

Null Hypothesis: LY has a unit root
Exogenous: None
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.710306	0.9789
Test critical values:	1% level	-2.578092	
	5% level	-1.942634	
	10% level	-1.615508	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LY)
Method: Least Squares
Date: 05/30/16 Time: 09:45
Sample (adjusted): 2000M04 2014M12
Included observations: 177 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LY(-1)	0.001280	0.000748	1.710306	0.0890
D(LY(-1))	-0.282062	0.073997	-3.811781	0.0002
D(LY(-2))	-0.222284	0.073982	-3.004551	0.0031

R-squared	0.099076	Mean dependent var	0.006538
Adjusted R-squared	0.088721	S.D. dependent var	0.077658
S.E. of regression	0.074133	Akaike info criterion	-2.349110
Sum squared resid	0.956251	Schwarz criterion	-2.295277
Log likelihood	210.8962	Hannan-Quinn criter.	-2.327277
Durbin-Watson stat	1.975737		

Table A- 2: Non-stationary Swaziland prices (LY) at I(1)

Null Hypothesis: D(LY) has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.77333	0.0000
Test critical values:	1% level	-2.578092	
	5% level	-1.942634	
	10% level	-1.615508	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LY,2)
Method: Least Squares
Date: 05/30/16 Time: 09:48
Sample (adjusted): 2000M04 2014M12
Included observations: 177 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LY(-1))	-1.476202	0.115569	-12.77333	0.0000
D(LY(-1),2)	0.208328	0.073934	2.817742	0.0054

R-squared	0.627734	Mean dependent var	0.000000
Adjusted R-squared	0.625607	S.D. dependent var	0.121821
S.E. of regression	0.074540	Akaike info criterion	-2.343738
Sum squared resid	0.972326	Schwarz criterion	-2.307849
Log likelihood	209.4208	Hannan-Quinn criter.	-2.329183
Durbin-Watson stat	1.970188		

Table A- 3: Non-stationary Import parity prices (LX5) at I(0)

Null Hypothesis: LX5 has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.551214	0.8343
Test critical values:	1% level	-2.578018	
	5% level	-1.942624	
	10% level	-1.615515	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LX5)
Method: Least Squares
Date: 12/30/16 Time: 19:52

Sample (adjusted): 2000M03 2014M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LX5(-1)	0.000429	0.000778	0.551214	0.5822
D(LX5(-1))	0.335592	0.071144	4.717085	0.0000

R-squared	0.111517	Mean dependent var	0.005518
Adjusted R-squared	0.106469	S.D. dependent var	0.080580
S.E. of regression	0.076169	Akaike info criterion	-2.300543
Sum squared resid	1.021112	Schwarz criterion	-2.264792
Log likelihood	206.7483	Hannan-Quinn criter.	-2.286045
Durbin-Watson stat	1.977917		

Table A- 4: Stationary import parity prices (LX5) at I(1)

Null Hypothesis: D(LX5) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.341539	0.0000
Test critical values:	1% level	-2.578018	
	5% level	-1.942624	
	10% level	-1.615515	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LX5,2)
Method: Least Squares
Date: 12/30/16 Time: 20:01
Sample (adjusted): 2000M03 2014M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LX5(-1))	-0.661695	0.070834	-9.341539	0.0000

R-squared	0.330208	Mean dependent var	0.000323
Adjusted R-squared	0.330208	S.D. dependent var	0.092887
S.E. of regression	0.076019	Akaike info criterion	-2.310054
Sum squared resid	1.022874	Schwarz criterion	-2.292179
Log likelihood	206.5948	Hannan-Quinn criter.	-2.302805
Durbin-Watson stat	1.978933		

Table A- 5: Non-stationary South African (LX1) prices at I(0)

Null Hypothesis: LX1 has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.430874	0.8058
Test critical values:	1% level	-2.578018	
	5% level	-1.942624	
	10% level	-1.615515	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LX1)
Method: Least Squares
Date: 05/30/16 Time: 10:12
Sample (adjusted): 2000M03 2014M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LX1(-1)	0.000387	0.000897	0.430874	0.6671
D(LX1(-1))	0.359515	0.070493	5.099999	0.0000

R-squared	0.128083	Mean dependent var	0.005440
Adjusted R-squared	0.123129	S.D. dependent var	0.092363
S.E. of regression	0.086490	Akaike info criterion	-2.046406
Sum squared resid	1.316569	Schwarz criterion	-2.010655
Log likelihood	184.1301	Hannan-Quinn criter.	-2.031908
Durbin-Watson stat	1.980706		

Table A- 6: Stationary South African (LX1) prices at I(1)

Null Hypothesis: D(LX1) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.097298	0.0000
Test critical values:	1% level	-2.578018	
	5% level	-1.942624	
	10% level	-1.615515	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LX1,2)
Method: Least Squares
Date: 05/30/16 Time: 10:14
Sample (adjusted): 2000M03 2014M12
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LX1(-1))	-0.638649	0.070202	-9.097298	0.0000

R-squared	0.318595	Mean dependent var	0.000387
Adjusted R-squared	0.318595	S.D. dependent var	0.104535
S.E. of regression	0.086291	Akaike info criterion	-2.056587
Sum squared resid	1.317958	Schwarz criterion	-2.038712

Log likelihood	184.0363	Hannan-Quinn criter.	-2.049338
Durbin-Watson stat	1.981441		

Appendix B. Econometric tests

Table B- 1: Engle-Granger test in LY (Swaziland domestic prices) and LX1 (South African prices)

Dependent Variable: LY
Method: Least Squares
Date: 05/25/16 Time: 13:24
Sample: 2000M01 2014M12
Included observations: 180

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LX1	0.730775	0.048647	15.02190	0.0000
C	2.228034	0.352084	6.328123	0.0000

R-squared	0.559032	Mean dependent var	7.507227
Adjusted R-squared	0.556555	S.D. dependent var	0.431272
S.E. of regression	0.287191	Akaike info criterion	0.353713
Sum squared resid	14.68124	Schwarz criterion	0.389190
Log likelihood	-29.83418	Hannan-Quinn criter.	0.368098
F-statistic	225.6576	Durbin-Watson stat	0.131470
Prob(F-statistic)	0.000000		

Null Hypothesis: RESIDECT has a unit root
Exogenous: None
Lag Length: 12 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.162912	0.0298
Test critical values:	1% level	-2.578883	
	5% level	-1.942745	
	10% level	-1.615438	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESIDECT)
Method: Least Squares
Date: 05/25/16 Time: 13:25
Sample (adjusted): 2001M02 2014M12
Included observations: 167 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESIDECT(-1)	-0.074593	0.034488	-2.162912	0.0321
D(RESIDECT(-1))	-0.052571	0.081926	-0.641690	0.5220
D(RESIDECT(-2))	0.067352	0.082096	0.820411	0.4132
D(RESIDECT(-3))	0.151461	0.081287	1.863281	0.0643
D(RESIDECT(-4))	-0.028079	0.082061	-0.342174	0.7327
D(RESIDECT(-5))	-0.066128	0.082070	-0.805746	0.4216
D(RESIDECT(-6))	0.001720	0.082138	0.020943	0.9833
D(RESIDECT(-7))	0.055556	0.081614	0.680721	0.4971
D(RESIDECT(-8))	0.091651	0.081620	1.122897	0.2632
D(RESIDECT(-9))	0.071735	0.082328	0.871330	0.3849
D(RESIDECT(-10))	-0.075856	0.082273	-0.922002	0.3580
D(RESIDECT(-11))	0.059974	0.082502	0.726942	0.4684
D(RESIDECT(-12))	0.002804	0.081995	0.034193	0.9728

R-squared	0.084107	Mean dependent var	0.003066
Adjusted R-squared	0.012739	S.D. dependent var	0.106461
S.E. of regression	0.105781	Akaike info criterion	-1.580250
Sum squared resid	1.723191	Schwarz criterion	-1.337532
Log likelihood	144.9509	Hannan-Quinn criter.	-1.481736
Durbin-Watson stat	2.005078		

Table B- 2: Engle-Granger in LX5 (Import parity prices) and LY (Swaziland domestic prices)

Dependent Variable: LY
Method: Least Squares
Date: 12/30/16 Time: 21:14
Sample: 2000M01 2014M12
Included observations: 180

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.395729	0.350335	3.983979	0.0001
LX5	0.832388	0.047641	17.47197	0.0000

R-squared	0.631676	Mean dependent var	7.507227
Adjusted R-squared	0.629606	S.D. dependent var	0.431272
S.E. of regression	0.262472	Akaike info criterion	0.173706
Sum squared resid	12.26271	Schwarz criterion	0.209183
Log likelihood	-13.63350	Hannan-Quinn criter.	0.188090
F-statistic	305.2696	Durbin-Watson stat	0.156256
Prob(F-statistic)	0.000000		

Null Hypothesis: RESIIECM has a unit root
Exogenous: None
Lag Length: 12 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.774857	0.0057
Test critical values:	1% level	-2.578883	
	5% level	-1.942745	
	10% level	-1.615438	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESIIECM)
Method: Least Squares
Date: 12/30/16 Time: 21:43
Sample (adjusted): 2001M02 2014M12
Included observations: 167 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESIIECM(-1)	-0.112162	0.040421	-2.774857	0.0062
D(RESIIECM(-1))	-0.116080	0.082182	-1.412472	0.1598
D(RESIIECM(-2))	0.090414	0.082565	1.095064	0.2752
D(RESIIECM(-3))	0.134155	0.080281	1.671067	0.0967
D(RESIIECM(-4))	-0.004438	0.080766	-0.054944	0.9563
D(RESIIECM(-5))	-0.034964	0.080711	-0.433194	0.6655
D(RESIIECM(-6))	-0.001822	0.080689	-0.022586	0.9820
D(RESIIECM(-7))	0.108920	0.079898	1.363233	0.1748
D(RESIIECM(-8))	0.109892	0.080263	1.369158	0.1729
D(RESIIECM(-9))	0.135211	0.081036	1.668535	0.0972
D(RESIIECM(-10))	-0.129789	0.081731	-1.588004	0.1143
D(RESIIECM(-11))	0.205779	0.082388	2.497686	0.0136
D(RESIIECM(-12))	0.098414	0.081649	1.205331	0.2299

R-squared	0.195146	Mean dependent var	0.002364
Adjusted R-squared	0.132430	S.D. dependent var	0.118426
S.E. of regression	0.110306	Akaike info criterion	-1.496468
Sum squared resid	1.873784	Schwarz criterion	-1.253750
Log likelihood	137.9551	Hannan-Quinn criter.	-1.397954
Durbin-Watson stat	1.973909		

Table B- 3: ECM test using LY and LX1

VAR Lag Order Selection Criteria
Endogenous variables: LY LX1
Exogenous variables: C
Date: 05/25/16 Time: 13:33
Sample: 2000M01 2014M12
Included observations: 172

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-126.2383	NA	0.015228	1.491143	1.527742	1.505992
1	365.3673	966.0621	5.25e-05	-4.178689	-4.068893	-4.134142
2	386.2351	40.52238	4.32e-05	-4.374826	-4.191833*	-4.300581
3	393.3995	13.74572*	4.16e-05*	-4.411622*	-4.155431	-4.307679*
4	395.2571	3.520706	4.27e-05	-4.386710	-4.057321	-4.253068
5	396.4719	2.274200	4.41e-05	-4.354324	-3.951737	-4.190984
6	397.4837	1.870791	4.56e-05	-4.319578	-3.843794	-4.126540
7	399.5894	3.844084	4.67e-05	-4.297551	-3.748570	-4.074815
8	403.5919	7.213719	4.67e-05	-4.297580	-3.675401	-4.045145

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Dependent Variable: D(LY)
Method: Least Squares
Date: 06/30/16 Time: 19:07
Sample (adjusted): 2000M05 2014M12
Included observations: 176 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009560	0.005666	1.687257	0.0934
D(LX1)	-0.019349	0.066931	-0.289084	0.7729
D(LX1(-1))	0.110955	0.071771	1.545947	0.1240
D(LX1(-2))	-0.134890	0.071739	-1.880289	0.0618
D(LX1(-3))	-0.000986	0.067159	-0.014684	0.9883
D(LY(-1))	-0.234121	0.078062	-2.999172	0.0031
D(LY(-2))	-0.220128	0.078103	-2.818420	0.0054
D(LY(-3))	0.080855	0.077617	1.041715	0.2990
NEWRESIDUAL	-0.038515	0.020881	-1.844502	0.0669

R-squared	0.143513	Mean dependent var	0.006911
Adjusted R-squared	0.102483	S.D. dependent var	0.077720
S.E. of regression	0.073630	Akaike info criterion	-2.329755
Sum squared resid	0.905362	Schwarz criterion	-2.167628
Log likelihood	214.0184	Hannan-Quinn criter.	-2.263997
F-statistic	3.497805	Durbin-Watson stat	1.985479
Prob(F-statistic)	0.000923		

Table B- 4: ECM using LX5 and LY

ECM lag selection

VAR Lag Order Selection Criteria
Endogenous variables: LY LX5
Exogenous variables: C
Date: 12/30/16 Time: 21:50
Sample: 2000M01 2014M12
Included observations: 172

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-97.84106	NA	0.010946	1.160943	1.197541	1.175792
1	350.3597	880.7667	6.25e-05	-4.004183	-3.894387*	-3.959636
2	356.0581	11.06543	6.13e-05	-4.023931	-3.840938	-3.949686
3	363.5841	14.43937*	5.88e-05*	-4.064931*	-3.808740	-3.960988*
4	364.6096	1.943719	6.09e-05	-4.030344	-3.700955	-3.896703
5	365.6001	1.854280	6.31e-05	-3.995350	-3.592763	-3.832010
6	366.2030	1.114742	6.57e-05	-3.955849	-3.480065	-3.762811
7	368.6997	4.557933	6.68e-05	-3.938369	-3.389387	-3.715633
8	370.6547	3.523517	6.85e-05	-3.914590	-3.292411	-3.662155

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Dependent Variable: D(LY)
Method: Least Squares
Date: 12/30/16 Time: 22:08
Sample (adjusted): 2000M05 2014M12
Included observations: 176 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009652	0.005700	1.693361	0.0923
D(LX5)	0.026956	0.056752	0.474980	0.6354
D(LX5(-1))	0.038467	0.057054	0.674230	0.5011
D(LX5(-2))	-0.074034	0.057613	-1.285021	0.2006
D(LX5(-3))	-0.045071	0.057069	-0.789770	0.4308
D(LY(-1))	-0.249302	0.077526	-3.215732	0.0016
D(LY(-2))	-0.203071	0.078041	-2.602101	0.0101
D(LY(-3))	0.062987	0.076837	0.819756	0.4135
NEWRESS	-0.046911	0.022995	-2.040076	0.0429

R-squared	0.134204	Mean dependent var	0.006911
Adjusted R-squared	0.092729	S.D. dependent var	0.077720
S.E. of regression	0.074029	Akaike info criterion	-2.318945
Sum squared resid	0.915201	Schwarz criterion	-2.156818
Log likelihood	213.0672	Hannan-Quinn criter.	-2.253187
F-statistic	3.235759	Durbin-Watson stat	1.991163
Prob(F-statistic)	0.001895		

Table B- 5: Symmetric price transmission in LY and LX1

Dependent Variable: D(LY)
Method: Least Squares
Date: 06/30/16 Time: 19:16
Sample (adjusted): 2000M05 2014M12
Included observations: 176 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.020900	0.009051	2.309032	0.0222
D(LX1)	-0.012699	0.066749	-0.190248	0.8493
D(LX1(-1))	0.100560	0.071731	1.401899	0.1628
D(LX1(-2))	-0.146247	0.071756	-2.038104	0.0431
D(LX1(-3))	-0.016429	0.067538	-0.243252	0.8081
D(LY(-1))	-0.222173	0.078056	-2.846333	0.0050
D(LY(-2))	-0.218348	0.077748	-2.808421	0.0056
D(LY(-3))	0.083167	0.077269	1.076329	0.2833
POSITIVEECT	-0.111788	0.050246	-2.224814	0.0274
NEGATIVEECT	-0.005177	0.029414	-0.176009	0.8605

R-squared	0.156548	Mean dependent var	0.006911
Adjusted R-squared	0.110819	S.D. dependent var	0.077720
S.E. of regression	0.073287	Akaike info criterion	-2.333728
Sum squared resid	0.891582	Schwarz criterion	-2.153587
Log likelihood	215.3681	Hannan-Quinn criter.	-2.260664
F-statistic	3.423371	Durbin-Watson stat	2.001939

Prob(F-statistic)	0.000688

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	-1.601742	166	0.1111
F-statistic	2.565577	(1, 166)	0.1111
Chi-square	2.565577	1	0.1092

Null Hypothesis: C(9)=C(10)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(9) - C(10)	-0.106611	0.066560

Restrictions are linear in coefficients.

Table B- 6: Symmetric price transmission in LX5 and LY

Dependent Variable: D(LY)
Method: Least Squares
Date: 12/30/16 Time: 22:19
Sample (adjusted): 2000M05 2014M12
Included observations: 176 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.025300	0.009099	2.780532	0.0061
D(LX5)	0.030740	0.056143	0.547531	0.5847
D(LX5(-1))	0.021750	0.056930	0.382057	0.7029
D(LX5(-2))	-0.093922	0.057688	-1.628111	0.1054
D(LX5(-3))	-0.063414	0.057048	-1.111580	0.2679
D(LY(-1))	-0.215386	0.078207	-2.754064	0.0065
D(LY(-2))	-0.192254	0.077326	-2.486270	0.0139
D(LY(-3))	0.071835	0.076085	0.944137	0.3465
POSECM	-0.165316	0.058639	-2.819228	0.0054
NEGECM	-0.000674	0.031024	-0.021730	0.9827

R-squared	0.158530	Mean dependent var	0.006911
Adjusted R-squared	0.112908	S.D. dependent var	0.077720
S.E. of regression	0.073201	Akaike info criterion	-2.336080
Sum squared resid	0.889488	Schwarz criterion	-2.155939
Log likelihood	215.5751	Hannan-Quinn criter.	-2.263016
F-statistic	3.474859	Durbin-Watson stat	2.013360
Prob(F-statistic)	0.000589		

Not that there are changes in the positive and negative of the errors

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability

t-statistic	-2.190620	166	0.0299
F-statistic	4.798815	(1, 166)	0.0299
Chi-square	4.798815	1	0.0285

Null Hypothesis: C(9)= C(10)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(9) - C(10)	-0.164642	0.075158

Restrictions are linear in coefficients.