Evaluating the prospect to hedge maize price risk against the Johannesburg Stock Exchange Commodity Derivatives Market prices: The case of Eswatini

By

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DECLARATION

I, L.N. Sihlongonyane, declare that the dissertation, which I hereby submit for the degree MSc Agricultural Economics at the University of Pretoria, is my own work and has not been submitted for a degree at this or any other tertiary institution.

27/01/21

Signature Date

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Degree:	MSc Agricultural Economics
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Abstract

Maize production remains low in Eswatini. The small country is still unable to meet the local demand through local production. Maize[1] is Eswatini's staple food but the country has not yet reached self-sufficiency. This deficiency or shortfall in local maize production has been a persistent problem since the country's independence. To fight this shortfall and reach self-sufficiency, the National Maize Corporation (NMC) was formed in 1985. The main purpose of the NMC is to keep the local demand satisfied. The NMC, as the only importer of white maize into Eswatini, does this by importing the deficit demand from South Africa. Stability of the local white maize price is also one of the responsibilities of the NMC.

This study's overarching aim was to determine whether or not a significant relationship exists between the maize prices as quoted on SAFEX[2] and the local maize price in Eswatini. This is done to see if the importer of maize in Eswatini, the NMC, can hedge the price risk on SAFEX. The study also maps the Eswatini imported and local maize value-chain through the current price discovery mechanism. Secondary data offered by the NMC and data from the Ministry of Agriculture in Eswatini and educational journals were used in the study. Econometric time series methods were used along with monthly data from 2008 to 2019.

Two hypotheses were tested during the study. The first hypothesis tested for the existence of a significant relationship between maize prices as quoted on SAFEX and the local maize price in Eswatini. The second hypothesis follows the first, determining whether or not hedging on SAFEX could be used as a tool to minimise price risk on the domestic price market in Eswatini.

The study confirms that a long-run relationship exists between the South African maize market and the Eswatini maize market. The study showed that a 1% increase in the South African price led to a 0.67% increase in the local Eswatini prices. This indicates a slow rate shift in prices. Short-run dynamics indicated a 12.5% adjustment to equilibrium per term, which is a slow adjustment as a result of market conditions in Eswatini. The study also revealed asymmetry in

1 Unless otherwise stated, "maize" refers to "white maize".
2 The JSE Ltd, formerly known as the Johannesburg Stock Exchange, acquired the South African Futures Exchange (SAFEX) in 2001. Today, commodities on the JSE are traded in the Commodities Derivatives Market (CDM) division. However, throughout this dissertation, the acronym "SAFEX" is used as it is still commonly used by the industry.

price transmission and that the Eswatini prices only respond to positive changes (price increase) in the South African prices. This reveals that the two markets are poorly integrated.

Due to the significant relationship between the two markets, it can be acknowledged that SAFEX could be used to hedge price risk by Eswatini through the NMC. Through mapping down the maize value-chain, the study discovered that the Eswatini maize market is not a liberalised one and value addition to maize through the chain is minimal. The relationship between the two maize markets, as well as the maize market of Eswatini, could still improve if means to liberate the market were to be exercised by the NMC and local government. This study can serve as the basis for understanding how risk management tools could be used by the Eswatini maize market and how the market could be improved or liberalised.

Keywords: Price transmission, maize prices, hedging, value-chain, SAFEX, NMC, South Africa, Eswatini

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List of Acronyms

CCU	Central Cooperative Union
ECM	Error Correction Model
FANRPAN	Food, Agriculture, and Natural Resources Policy Analysis Network
FAO	Food and Agricultural Organisation of the United Nations
JADAFA	Joint Agribusiness Department of Agriculture Forum for Africa
JSE CDM	Johannesburg Stock Exchange Commodity Derivatives Market
JSE	Johannesburg Stock Exchange
LOOP	Law of One Price
MOAC	Ministry of Agriculture and Cooperatives
NAMBOARD	National Marketing Board
NMC	National Maize Corporation
PEU	Public Enterprise Unit
RDA	Rural Development Areas
SACU	South African Customs Union
SADC	Southern African Development Community
SAFEX	South African Futures Exchange
SAGIS	South African Grain Information Service
SARS	South African Revenue Service
SNL	Swazi Nation Land
TDL	Title Deed Land
VAR	Vector Auto-Regressive
VECM	Vector Error Correction Model

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CHAPTER 1 INTRODUCTION

1.1. INTRODUCTION

Since independence in 1986, the country of Eswatini has had the main goal of achieving food security and self-sufficiency, with maize production being the main focus. Not only is maize one of Eswatini's main staple foods, the country also has considerable favourable weather conditions when it comes to planting the crop. Maize production is furthermore undertaken by almost every household within the country (The Food Agriculture And Natural Resources Policy Analysis Network, 2003).

Eswatini entrusts the National Maize Corporation (NMC) to boost and improve agricultural productivity along with national food security by enhancing stakeholder relationships; forming smart alliances; supporting maize farmers; ensuring a high standard marketing; and ensuring a high-quality supply of maize and other grains and cereals, with white maize being their biggest focus. The NMC has the responsibility to ensure that Eswatini's maize farmers retain a good market for their maize, guaranteeing a market in which farmers can sell their maize easily. On the other hand, the NMC is also responsible for ensuring that maize is available to the consumer at a reasonable price all year round. The NMC furthermore has as its goal the improvement of Eswatini's maize marketing system to cut down barriers and costs to marketing and to Eswatini's farmers by enhancing the maize market's efficiency through low-cost supply and low prices to all regions of the country (NMC, 2016). This is done through efficient storage; farmer supervision; price information; and providing accessibility to drying services.

The shortage in local maize supply continues to be one of the greatest challenges the NMC faces, regardless of the 12 per cent increase in maize production (from 101 041 metric tonnes in 2013/2014 to 113 039 metric tonnes in 2017/2018) (Figure 1.1). The increase in maize production can largely be attributed to an increase in area planted, a result of farmer confidence during seasons of good rains (NMC, 2016). In 2015/2016 the country was hit by a severe drought which resulted in a drop in local production quantities.

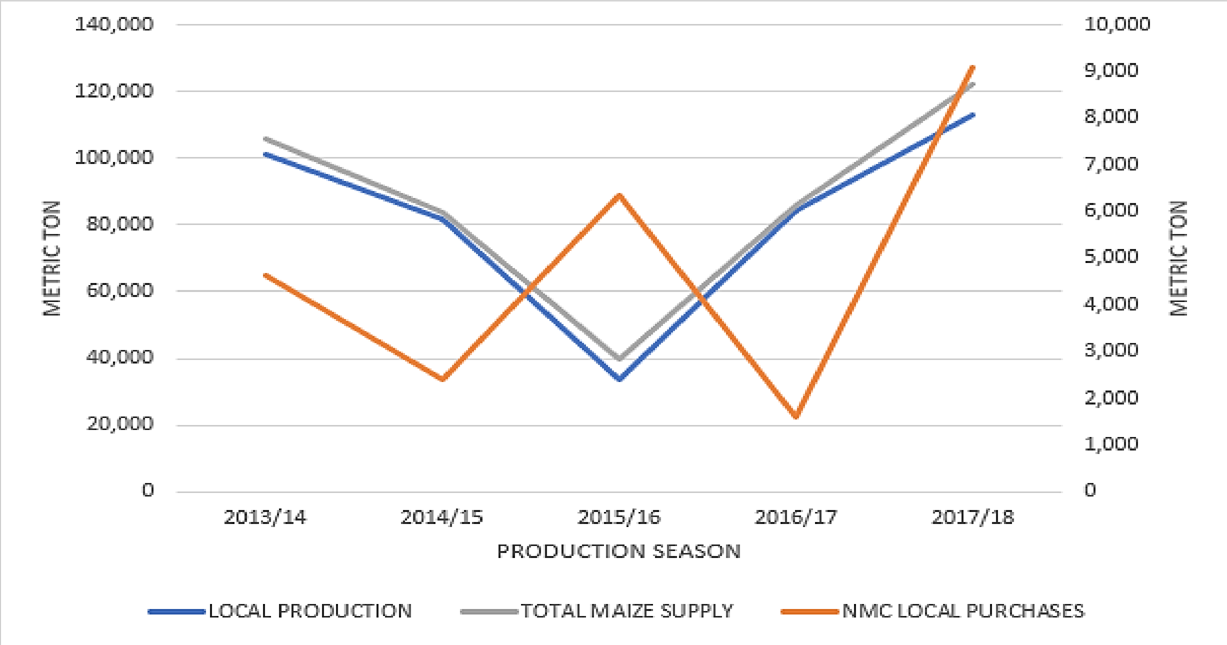

Figure 1.1 Historical maize production (2013/14 to 2017/18) (MT)

Source: NMC, 2018

Eswatini's domestic maize market, being a net importer of white maize grain, is vulnerable to world markets, especially that of the South African market from which it imports by far the majority of its supply and in some years all of it. All of the NMC's imports originate from South Africa (NMC, 2016) (Table 1.1). Table 1.1 below only shows the supply and demand for 5 years, 2013 to 2018.

Table 1.1 White maize supply and demand (2013/2014 to 2017/2018) (MT)

						5 Year Average
Year	13/14	14/15	15/16	16/17	17/18	2013-2018
CEC (Crop Estimate)	101,041	81,623	33,460	84,344	113,039	82,701.4
CEC (Retention)	96,422	79,233	27,119	82,758	103,965	77,899.4
SUPPLY						
Prod deliveries	4,619	2,390	6,341	1,586	9,074	4,802
Imports	15,704	29,584	27,649	45,428	22,925	28,258
Total Supply	**20,323**	**31,974**	**33,990**	**47,014**	**31,999**	33,060
DEMAND						
Processed	20,323	31,974	33,990	47,014	31,999	33,060
Total Exports	0	0	0	0	0	0
Total Demand	**20,323**	**31,974**	**33,990**	**47,014**	**31,999**	33,060

Source: Adapted from NMC, 2018

Maize, as a commodity, is traded on SAFEX[3]. The prices fluctuate all the time subject to supply and demand. SAFEX acts as a stage for price detection and competent price risk management in South Africa, and also in Southern Africa, when it comes to grains, more specifically maize (NMC, 2016). Since the NMC imports most of its maize from South Africa, the argument could be made that Eswatini could possibly hedge its maize price risk on SAFEX, if the countries' price movements are correlated.

Understanding the price relationship or, stated differently, price transmission[4] between SAFEX maize prices and that of Eswatini's maize prices, as well as the extent to which prices quoted on SAFEX affect the local maize prices in Eswatini, is important for price risk management purposes. Eswatini's maize importers must understand how local maize prices respond to SAFEX prices in South Africa as it could ultimately assist in managing price risk by employing relevant instruments in price risk management practices. Proper price risk management practices act as a shield against adverse prices changes.

As of 2019, research on the relationship between Eswatini maize prices and South African maize prices and how the latter's prices are shifted to Eswatini's prices are still limited. With such a high dependence on imports, understanding and studying the external price impact (SAFEX) on the domestic markets of Eswatini is vital for Eswatini in that it could potentially reduce the adverse price risk associated with the procurement of maize. To aid importers of maize in stabilising Eswatini's domestic maize prices, it is not only important to establish the right tools to do so, but also to determine the extent to which price risks could be managed. It is not only the price of imports that is dependable on South African maize prices, but due to the impact of price transmission, all of the local Eswatini market is impacted. Therefore, the starting point for researchers is to understand the relationship of maize prices between Eswatini and those of SAFEX.

3 The JSE Ltd, formerly known as the Johannesburg Stock Exchange, acquired the South African Futures Exchange (SAFEX) in 2001. Today, commodities on the JSE are traded in the Commodities Derivatives Market (CDM) division. However, throughout this dissertation, the acronym "SAFEX" is used as it is still commonly used by the industry.
4 Price transmission can be defined as the effect one market's prices have on prices in another market.

1.2. PROBLEM STATEMENT

While consumers are negatively affected by high prices, producers are very much motivated by them (T. N. Dlamini, 2017). This is because producers seek to obtain the highest possible price (ensuring the highest possible revenue), while consumers seek to buy at a lesser price (ensuring the lowest possible cost). Understanding this enables the country, through the NMC, to cater to both consumers and producers in setting maize prices.

Since the local supply of maize remains short, Eswatini has no other choice but to rely on imports (mostly from South Africa) to fill the gap. As a result, vast amounts of capital are being utilised for maize imports in an attempt to try to meet the demand of the country. This ultimately means that Eswatini is exposed to price risks. Such risks can increase the procurement price and result in high local end prices that are faced by processors and consumers.

Price risk can be countered by hedging[5]. Better understanding the value chain of maize, including imports and the ability to manage price risk through hedging on SAFEX, should contribute to price stability on the Eswatini markets. The problem with most agricultural commodities is seasonality, i.e. supply is subject to weather, but demand is mostly constant all year round. If there is a relationship between Eswatini's local maize prices and South Africa's maize prices (SAFEX), then the NMC can hedge price risk on SAFEX. The following questions therefore arise:

1) What is the relationship, if any, between the price of maize as quoted on SAFEX and the domestic Eswatini maize price?

2) Can importers of maize in Eswatini hedge price risk on SAFEX?

Findings from this research could be used to manage price risk for both maize producers, processors, and ultimately, the NMC. The results from this study could be integrated with price

5 Hedging refers to an action taken by a buyer or seller of a commodity to protect his/ her income against adverse price movements in the future (Krugel, 2003).

making policies to ensure a competitive price for Eswatini's producers, while still providing a fair price to consumers. This, in turn, could support the advancement of the maize industry in Eswatini. The results of this study could also provide an insight into how the NMC could possibly import maize at stable prices, by managing price risks, thus stabilising the local selling price. Distributional constancy between food surplus and areas of shortage in third world countries can be achieved through the know-how of the speed of price movement between geographically or spatially disconnected marketplaces (Awudu Abdulai, 2007). Understanding price transmission, therefore, helps in keeping the distribution of food between two spatially separated markets. The study will also serve as an important tool to arbitrageurs seeking profit through the food supply and price transmission. The study will also give input in creating or improving policies that safeguard maize importation and how it is marketed within the country.

1.3. AIM AND OBJECTIVES OF THE STUDY

The overarching objective of this research project is determining if price risk in the domestic Eswatini maize market could be reduced through hedging on SAFEX, by means of analysing the relationship between maize prices as quoted on SAFEX and the Eswatini local market. Correlation levels between the two prices will determine the validity of using SAFEX as price risk management tool. The research aim is accompanied by the following sub-objectives:

1) Determining if there is a significant relationship between the maize price as quoted on SAFEX and the local maize price in Eswatini. An analysis will be done to test for correlation between the Eswatini's local price and maize prices as quoted on SAFEX by using econometric methods. The Asymmetric Error Correction Model (AECM) under the time series method will be used.

2) Mapping the Eswatini imported and local maize value chain through the current price discovery mechanism. This will be done by illustrating and explaining the movement of maize from South Africa to the local Eswatini maize market as the price of maize changes.

1.4. HYPOTHESIS

Since the overarching aim of this research study is to determine if price risk in the local Eswatini maize market could be reduced through hedging on SAFEX, the main hypothesis to be tested is stated as follow:

H_0: Hedging on the SAFEX can be used as a tool to minimise price risk in the domestic maize market in Eswatini.

It follows that it is necessary to first estimate if there exists a significant relationship between maize prices as quoted on SAFEX and local maize prices in Eswatini. Thus, the following hypothesis necessarily needs to be tested:

H_0: There exists a significant relationship between maize prices as quoted on SAFEX and local maize prices in Eswatini.

1.5. OVERVIEW OF CHAPTERS

The chapters of the study will be as follows. Chapter 2 will provide an overview of the Eswatini maize industry, touching on topics that will greatly breakdown the problem in question. This chapter will include the value chain, maize marketing, trade, and price formulation in the maize industry in Eswatini. The third chapter will review the empirical findings and theories reported previously by researchers on price transmission, market integration, and hedging. Chapter 4 will focus on the value chain and how prices are discovered, both in local and in import markets. In Chapter 5, the methods that will be used in the analysis will be discussed. The following chapter, Chapter 6, will provide the analysis and results, together their discussion. Chapter 7 will present a conclusion concerning the findings of the study and also tackle possible areas that could further be researched.

CHAPTER 2 OVERVIEW OF ESWATINI MAIZE INDUSTRY

2.1. INTRODUCTION

Maize serves as a staple crop in Eswatini, particularly white maize. Cereal production in Eswatini comprises ninety-five per cent white maize (Mano, Isaacson, & Dardel, 2003). Maize is cultivated on Title Deed Land (TDL) and Swati Nation Land (SNL), the first accounting for sixty per cent of total arable land. On TDL, maize is grown for commercial purposes and employs the use of full management practices such as irrigation, whereas producers only employ traditional practices and rely on rain on SNL. Although almost every household produces maize in the country, sufficient levels of production, historically, have never been met. This is due to maize production being subsistence in focus (S. I. Dlamini, Masuku, & Rugambisa, 2012).

When it comes to quantities purchased, the NMC remains unable to meet market demand, i.e. the NMC is unable to procure sufficient quantities of maize due to the price being highly regulated by the government. When it comes to the buying price, the government of Eswatini sets the limits in price that the NMC should use when buying maize. As of 2017, the buying price from local farmers by the NMC was fixed at not less than E2 600 per ton. This changes every year, depending on the supply and demand forces. If the SAFEX price of maize happens to be above the local price, then the NMC can buy maize from the farmer at the same rate as that obtained from SAFEX. On the other hand, the selling price of maize must not be more than ten per cent (10%) above the break-even price, which is the average of the costs of imported and locally sourced maize. The break-even price also includes the buying price and management costs for both locally sourced and imported maize (NMC, 2016).

It is suspected that the low productivity in maize farming, and ultimately the failure of the country to meet its demand for maize, is a result of the availability of internationally supplied food aid, as well as poor farming practices (Mabuza, Hendriks, Ortmann, & Sithole, 2009). Mabuza *et al*. (2009), however, argues that food aid does not contribute to low productivity in maize production in Eswatini and therefore does not affect the domestic price of maize in the country.

Due to overall beneficial weather, which encouraged farmers to produce more, food insecurity numbers reduced in 2018 as increments in production of maize were estimated (Outlook, 2018). The forecast of the 2018/2019 marketing year estimated that cereal imports would decrease due to the expected increase in local harvests and that a decline in maize prices would arise due to sufficient domestic supplies and lower import prices (Outlook, 2018).

However, when faced with shortages in the maize supply in Eswatini, the importation of white maize remains the main solution for meeting the nation's demand for the commodity. With over ninety per cent of imported maize originating from South Africa, the reliance on South Africa for maize is significant. Agricultural prices furthermore exhibit cyclical behaviour due to the biological nature of all products produced. This, in turn, presents price risks. The local white maize prices in Eswatini are generally higher than those in South Africa and other neighbouring countries that it imports from (NMC, 2016).

Chapter 2 of this dissertation will provide an overview of the Eswatini maize industry, touching on topics that will greatly assist to classify elements of the problem in question, as stated in Section 1.2. This chapter will map the Eswatini maize value chain, focusing on the Eswatini maize marketing system, trade, and price formulation in the maize industry in Eswatini.

2.2. HISTORY OF THE ESWATINI MAIZE INDUSTRY

To date (2020), the agricultural industry of Eswatini encompasses a modern and traditional economy, reflecting dualism in the economy. Cash crops such as tobacco characterise the modern sector, cultivated on private farms, whereas maize symbolises the traditional (old) sector, where crops are grown primarily for subsistence purposes. Production for sale was never the aim when maize farming was considered (Sibisi, 1981). However, with high levels of production in mind, the government took it into its hands to transform maize production from subsistence farming to commercial farming in 1971.

With self-sufficiency in maize supply in mind, i.e. transforming the traditional maize sector to a commercial maize sector, the government of Eswatini involved itself in the increased production of maize through the Ministry of Agriculture, previously known as the Ministry of Agriculture and Cooperatives (MOAC). This was done by enabling the private sector to take part in the production of maize. The government of Eswatini furthermore developed programmes and guidelines to enhance maize yields (Dube & Musi, 2002).

The Central Cooperative Union (CCU) was formed in 1971 and assembled cooperatives to enable farmers in isolated areas to have access to services (Hlatshwako, 2009). Maize was collected at the cooperatives around the country to be processed by the Swaziland Milling Company, which was the sole commercial miller at that time (Sithole & Apedaile, 1987). With the option to sell in either the formal market (which consisted of cooperatives and the Swaziland Milling Company) or the informal market (consisting of neighbours, friends and relatives), farmers favoured the informal market due to the poor transportation available to reach the miller (Sachs & Roach, 1983). Regardless of such efforts, maize production in the country deteriorated.

In 1973, the Rural Development Areas (RDAs) programme was established through fiscal policy to address the problem of dualism (Fund, 1995). Twenty-nine RDAs were established around the country, all with the sole purpose of increasing farmers' returns through increased production (Vletter, 1984). This centre became responsible for agricultural production, and through it, the Eswatini government subsidised farmers in efforts to increase production. Farmers were subsidised with several core inputs, such as fertiliser, hybrid seeds, credit facilities, and tractor services. Despite the aforementioned efforts, maize production still declined and prices increased (Sachs & Roach, 1983). This was the result of poor extension services, i.e. farmers lacked the knowledge and skills as to how to incorporate these inputs with their traditional ways of farming, and most farmers used such inputs for purposes other than maize production. As the RDAs did not attain their goal, the Eswatini government had to take on another angle to achieve its goal of improving production by forming farmer co-ops.

Agricultural importing countries such as Eswatini suffered from higher costs over the period 1979 to 1980, where international maize production failed, causing financial misfortune (Grynberg & Motswapong, 2009). Eswatini imports increased as required to satisfy local demand, which stressed government revenues and food prices. For 15-odd years, the trend persisted, at an average of a 25 000-tonne increment in total maize imports per year (Fund, 1995). This event also affected processors and consumers who were forced to pay higher prices, which affected food availability and nutrition. Producers, on the other hand, lacked access to the proper tools and infrastructure to benefit from the high price level. Due to organisational and infrastructural issues, marketing was greatly crippled. The government started to make moves to liberate the market.

2.3. ESWATINI MAIZE MARKETING

Traditionally, liberalisation-based market reforms have little or no government intervention. This, however, is not the case with the Eswatini government. The Eswatini government plays a significant role in the maize market. Due to the poor marketing system, pulling the country's economy down, the government redefined its marketing system, restructuring it in 1985 (T. N. Dlamini, 2017). This was done through the introduction of the NMC, with the overarching aim of achieving self-sufficiency and regulating floor prices.

With the introduction of the NMC in 1985, another institution was established to revamp the marketing system of the country, i.e. the National Marketing Board (NAMBOARD). The milling sector was run by the NMC, which later contracted it to the Swaziland Milling Company due to its superior experience and connections. NAMBOARD, on the other hand, had the role of issuing import licences and regulating the agricultural markets. In 1995, the Swaziland Milling Company was suspended due it its failure to meet both customer and farmer requirements (Magagula & Faki, 1999). Low-quality maize and the low quantity of maize made available locally to the mill were some key reasons why the Swaziland Milling Company was unsuccessful, and milling operations reverted to the NMC. However, that arrangement did not last for long. Ngwane Mills, under the auspices of the Swaziland Milling Company, was in control of maize milling as of 2019.

The NMC gained partial independent management of its day-to-day operations, over time. The NMC is a government parastatal and monopoly importer of maize. This is so to protect the local maize market by making sure the imported maize quantities do not distort domestic production. The government remains the main controller of floor prices, although the NMC is responsible for keeping the maize market stable (Agriculture, 1998). The NMC furthermore remains the only company providing linkages among producers/suppliers and millers in the supply chain.

2.4. ESWATINI MAIZE MARKETING CHAIN

The maize marketing chain, although still a liberalised market, has over the years of continuous market reform, evolved into a complex market system. This complex market system is explained in Sections 2.4.1 to 2.4.3 below. Figure 2.1 graphically illustrates what the maize marketing chain looks like today (2020).

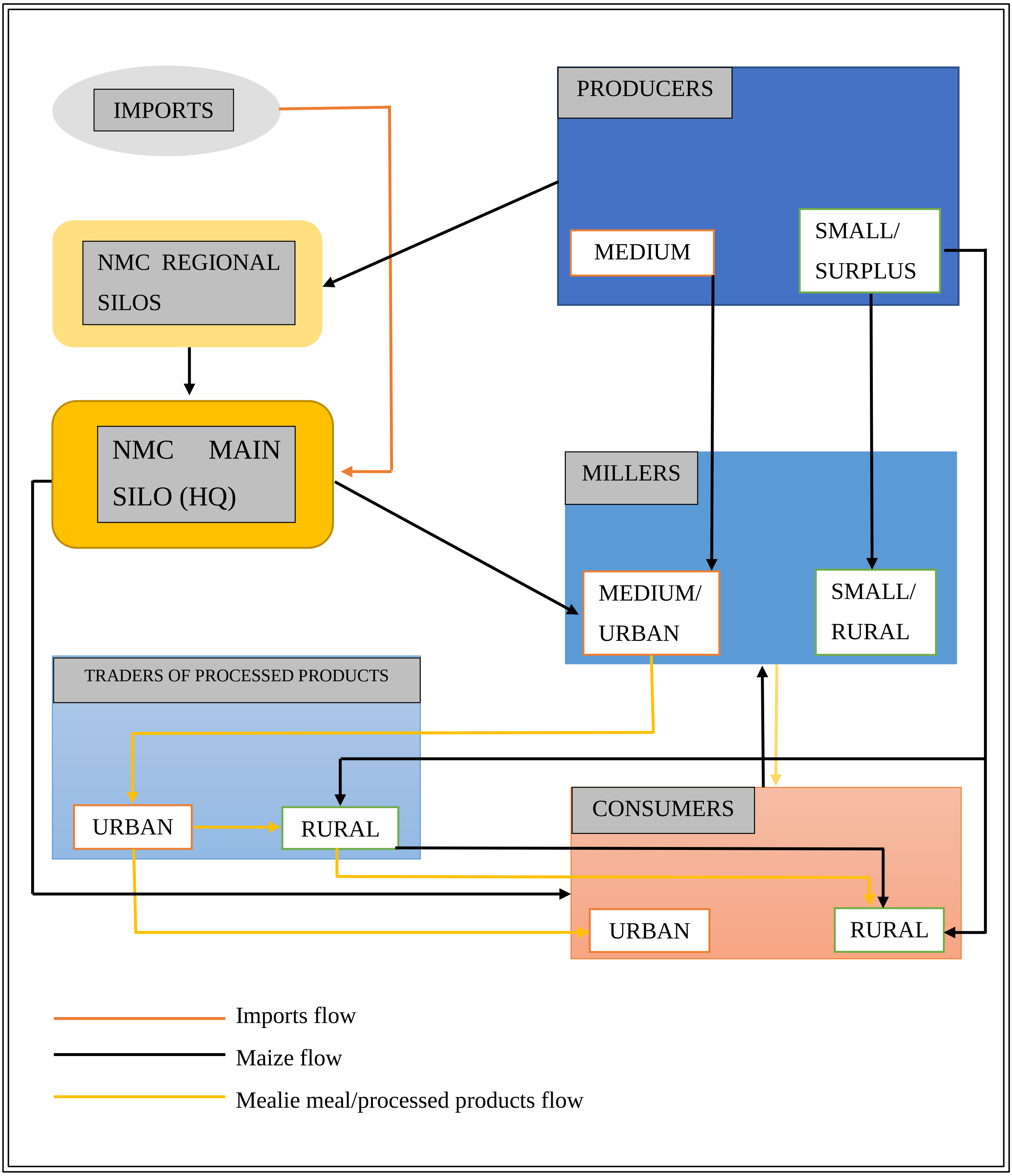

Figure 2.1 The Maize Marketing Chain in Swaziland (2020)

Source: Adapted from NMC and the Ministry of Agriculture (Eswatini)

2.4.1. Maize Production in the Eswatini Maize Industry

Providing sixty % of the total dietary needs of Eswatini's population, with ninety-five per cent accounting for the entire cereal production of the country, maize remains the staple food of Eswatini (Mano *et al*., 2003). Maize is grown on both SNL and TDL, chief controlled (forty per cent) and privately owned (sixty per cent), respectively (Magagula & Faki, 1999). The average yields on SNL and TDL are 4.22 ton/ha and 9.75 ton/ha, respectively (D. Dlamini & Masuku, 2011). As previously mentioned in Section 2.1, SNL encompasses many numbers of farms, as compared with those in the private sector. The SNL relies on rainfall while the private sector has the necessary resources to produce better yields. This leads to the short domestic supply and importation from South Africa. Since 2013/2014, importation makes up roughly 20–25% of total consumption in a so-called "normal" year.

Between the years 2001 and 2012, there was an upward trend in demand. Unfortunately, Eswatini experiences a shortfall of about 65 000 tons of maize annually, with local production at 80 000 tons. Farmers sell their maize either to the NMC or to the informal sector, as noted earlier in Section 2.2. With the help of associations formed by small-scale farmers, they can sell their white maize produce with greater ease.

2.4.2. Processing and Retailing in the Eswatini Maize Industry

Commercial maize farmers deliver their maize to formal maize millers, while small-scale farmers deliver their maize to both urban (formal) and rural (informal) zones, depending on which is most easily accessible (Figure 2.1). Both small-scale and commercial farmers utilise subsidised producer prices through working with the NMC (NMC, 2014). Formal millers use prices dictated by the NMC to buy maize from farmers, while informal millers use the spot market price, which is usually lower than that which is stated by the NMC.

There are four formal millers in the country selling their products to both urban and rural retailers, as well as the public at large, i.e. Universal Milling, Ngwane Mills Ltd, Dalcrue Holdings and Nkoyeni Milling. Ngwane Mills and Universal Milling have 60 per cent and 25 per cent of the market share, respectively, and by far dominate the milling market (JADAFA, 2014).

2.4.3. Trade in the Eswatini Maize Industry

Farmers in the traditional sector store enough grain to feed themselves until the next harvesting season. Farmers make use of plastic drums, bags and metal tanks to store their maize harvest. Surplus stock is sold to private buyers and the NMC. Most of these sales occur from May to August (T. N. Dlamini, 2017). As Figure 2.1 depicts, the NMC stores its maize in silos positioned around Eswatini's four regions, one in each region. Maize is then transported to the primary silo located in Matsapha, which makes a total of five storage places. With a capacity at 23 500 metric tons[6], these silos are large enough to supply local millers (The Food Agriculture And Natural Resources Policy Analysis Network, 2013). The NMC sells collected maize to individual consumers and millers in dissimilar amounts.

As stated earlier in Section 2.3, the NMC is a parastatal (owned or controlled partly by the government) specialising in white maize and the rice trade. Key stakeholders of the corporation are NAMBOARD and the Ministry of Agriculture (Agricultue, 1998). The principal purpose of the NMC revolves around the supply of good quality maize and maize meal to the country, as well as the provision of good marketing services to domestic farmers. It is the centre of the maize market in Eswatini, as it alone has the power to import white maize grain into the country.

Eswatini imports its white maize from countries within the Southern African Development Community (SADC), including South Africa, Namibia and Zambia. As mentioned earlier, the bulk of the maize is imported from South Africa (NMC, 2014). Imports are also regulated through the South African Customs Union (SACU) (South African Customs Union, 2012) agreement. Eswatini and South Africa operate in one exchange area, namely SADC, which means they are in a free trade area, and goods from either country attract little to no excise tariffs.

[6] Note, only a small percentage of total production ends up in commercial silos.

South Africa and Eswatini furthermore share a Common Monetary Area Agreement (CMAM), which means that the South African Rand converts directly to the Lilangeni. As a result, commercial imports from South Africa suffer no foreign exchange problems. Figure 2.2 summarises the flow of white maize to Eswatini from South Africa. Maize from South African commercial farmers is taken to regional silos, and then traded and exported to Africa. Through the trade border controlled by SACU, maize is then exported to Eswatini.

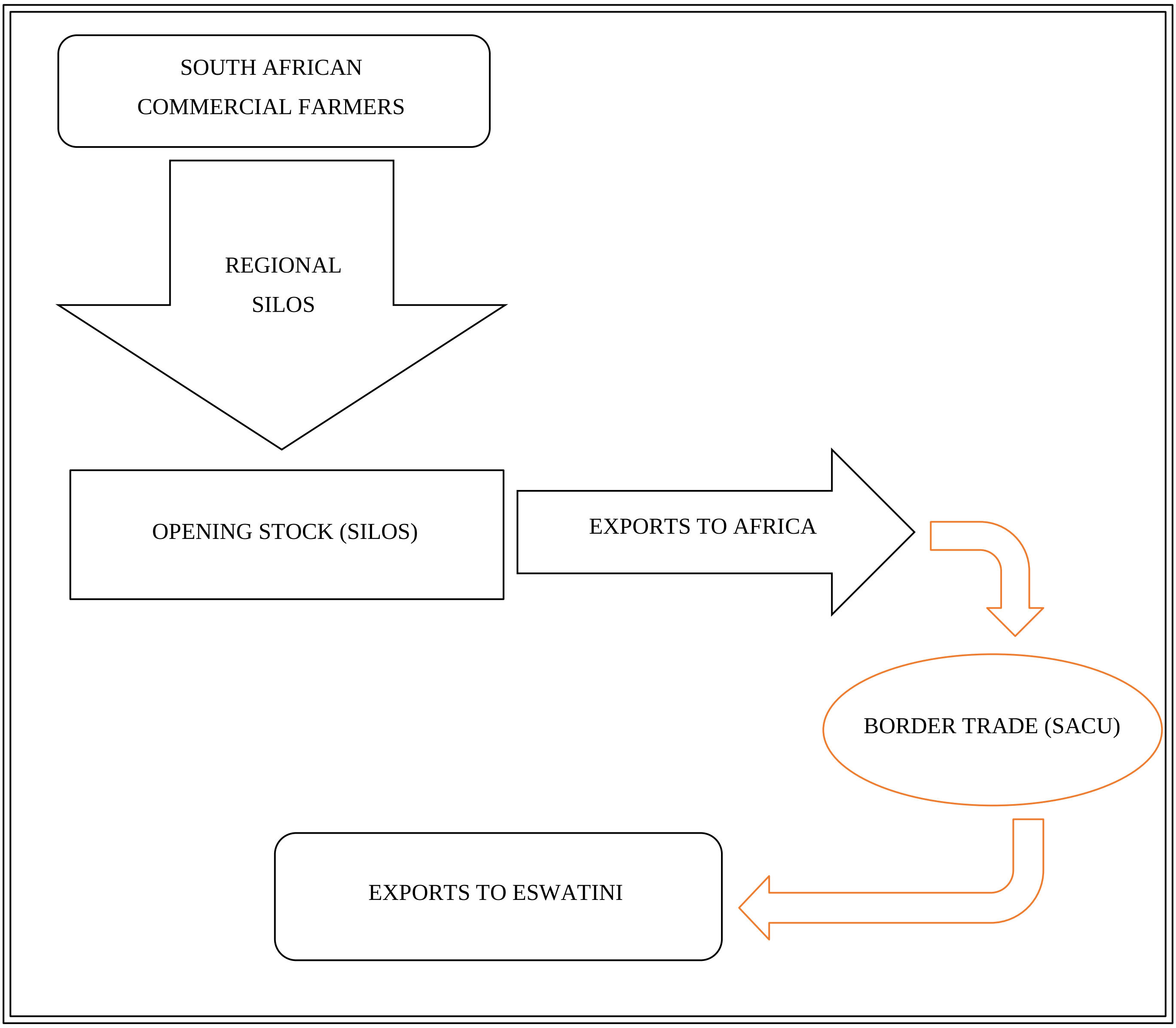

Figure 2.2 White maize flow: From South Africa to Eswatini (2020)

Source: The South African Revenue Service, 2017

2.5. PRICE FORMULATION IN THE ESWATINI MAIZE INDUSTRY

The Marketing Advisory Board (consisting of consumer associations, NAMBOARD, miller representatives, the Ministry of Agriculture, and the NMC) decides on an annual local purchase price for maize when the maize marketing year starts for the year in April. An increase in production costs led to a price increase from E2 435/ton to E2 575/ ton in 2015/16 (FAO, 2015). Surplus supplies from farmers, usually in small quantities, are sold at any of the NMC's silos. This unfortunately only brings about small profits due to the long distances travelled from the farms to the silos, and as a result, farmers prefer local sales, mostly in their own communities. Drying and fumigation costs charged by the NMC also add to the farmers' costs (FAO, 2015).

The spot market price is used when purchasing maize from South Africa by the NMC and efficient price risk management is still hard to achieve since the NMC, as of 2015, did not practise price hedging (FAO, 2015). Even today, the NMC does not practise price hedging.

A fixed retail (selling) price of white maize is established by the NMC, along with the purchase price from local producers. Such a regulated price structure limits the national average maize meal variation, which would lead to consumers not immediately benefiting from price drops in South Africa. On a positive note, it could also protect the consumer against price increases.

Floor prices for maize producers and price ceilings for consumers are controlled by the government through the Ministry of Finance (Mabuza *et al*., 2009). Although policy guides the official selling and buying prices, the market price is set by supply and demand forces in the informal sector where producers sell privately to millers and consumers.

The Marketing Advisory Board sets the producer floor price (buying price), but the buying price is also gazetted by the government in its safeguarding of supply chain members to ensure that they are not worse off.

In Figure 2.3 it is shown that the NMC buys dry maize grain from producers at the buying price, while the NMC also subsidises the buying price, as mentioned before. Millers and consumers buy maize from the NMC using the selling price. The Ministry of Finance uses its Public Enterprise Unit (PEU) to help the NMC in setting this price so that it does not suffer negative profits. Over the years, price adjustments have been made using SAFEX and other factors as a reference point.

During the setting of the selling price, the monthly average maximum of the SAFEX price acts as a reference for Eswatini's selling price, thereby making it reflect SAFEX prices. This becomes the selling price of NMC to the mills and to consumers who wish to buy whole maize. Other factors like production costs are taken into consideration during this price setting. In anticipation of the risk of higher South African white maize futures prices, Eswatini's local prices are kept higher than SAFEX prices for the whole year (The Food Agriculture And Natural Resources Policy Analysis Network, 2013). All factors affecting prices are not necessarily taken into consideration and the percentage on the price adjustment is not fixed (T. N. Dlamini, 2017).

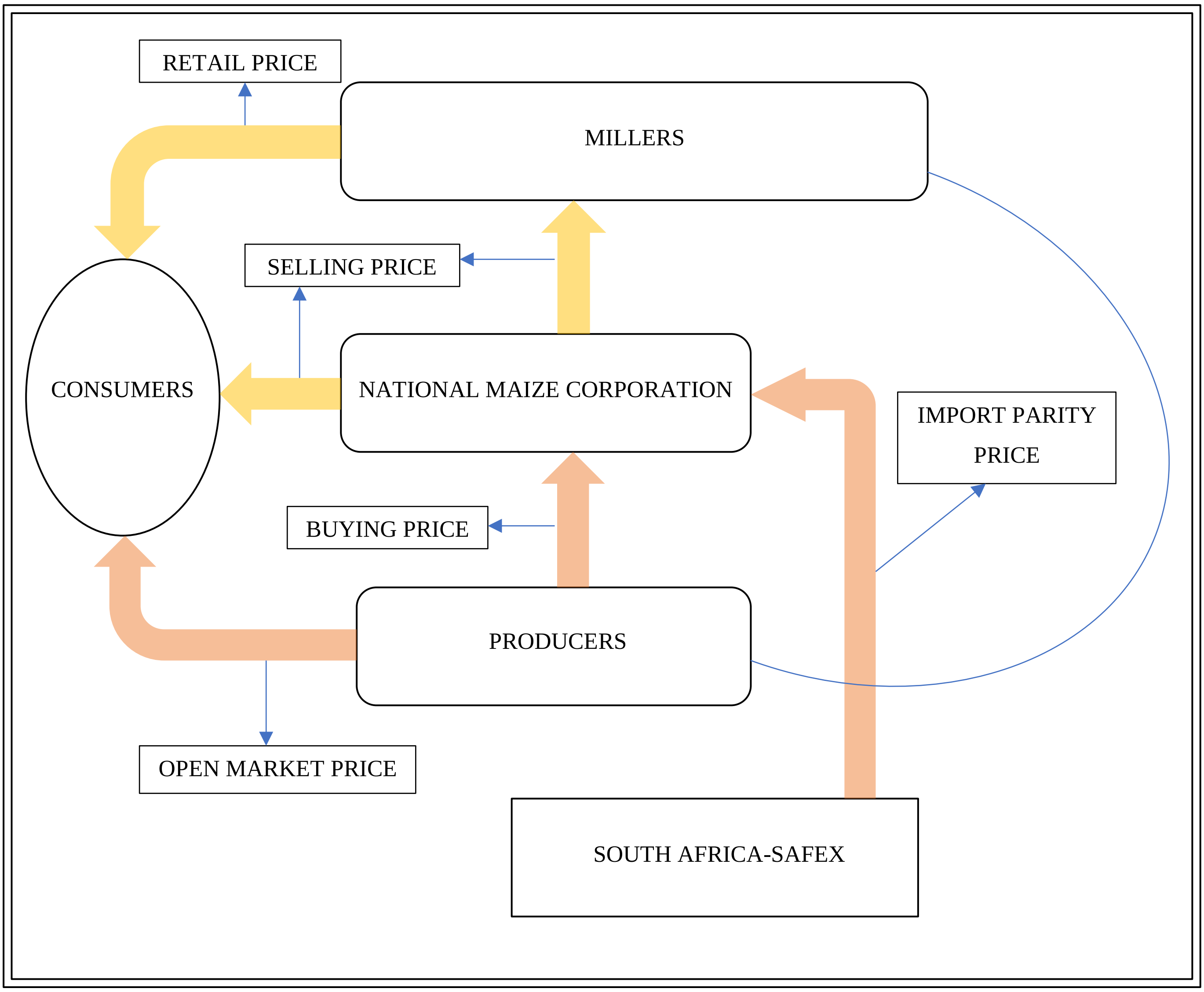

Figure 2.3 Pricing system in the white maize industry (2020)

Source: Adapted from NMC and the Ministry of Agriculture (Eswatini)

Import parity prices determine Eswatini's local selling and buying prices. Transport, levies and the SAFEX price make up the import equivalence price. Production costs and the import parity price are used to estimate the buying price (NMC, 2005). The NMC's operational costs, together with the import parity price, are used in determining the selling price. The selling price is higher than the buying or import parity prices, thus ensuring that the NMC breaks even or makes a profit. Farmers are encouraged by the NMC to sell their produce during periods of scarcity.

2.6. CONCLUSION

The maize industry in Eswatini has experienced little to no change in how it operates over the years. Most production still comes from the SNL, which is characterised by rather poor quality and poor output. This keeps the local production at low levels, insufficient to cater for the whole nation. Price formation remains under the control of the government and the NMC through the pricing policy, which is dependent on South African prices. Domestic prices are then set following the policies created. Such policies and their implementations have led to the NMC being the only importer of maize in the country, resulting in a dual pricing system of the informal and official prices.

The local production remains fairly constant, despite all the efforts of the Eswatini government in trying to boost it, and the country relies on imports to ensure a sufficient supply of maize to meet local demand. This has implications for food affordability and nutrition since consumers in Eswatini are faced with higher buying prices. If Eswatini could better manage the import cost of maize, possibly reducing it through price hedging on SAFEX, it could potentially reduce the maize meal buying price for consumers. This warrants analysing the correlation between local prices and the SAFEX prices in this study. It will also indicate whether or not Eswatini could avoid price risks while importing maize from South Africa.

CHAPTER 3 THE MAIZE VALUE CHAIN OF ESWATINI

3.1. INTRODUCTION

This chapter gives an in-depth continuation of the previous chapter, Chapter 2. It looks deeper into the maize marketing and value chains of Eswatini by examining the roles of each actor in the respective chains.

3.2. LITERATURE ON APPROACHES TO VALUE CHAINS

A value chain has been discussed by reference to many names in literature, such as a supply chain, market channel, market chain, and value-added chain. A value chain has actors at each point of the channel. Products move from one point and actor to the next, and change in value through each process. Each stage of the value chain may represent a transaction, indicating that a cost is being incurred, and mostly value is added to the product (Munna, 2015). It has been argued by a great number of research outputs that the performance and the efficiency in a certain market are affected by transaction costs. Higher transaction costs represent a higher effect and impact on the performance of that market (Vachani, Doh, & Teegen, 2009). The empirical literature, on the other hand, draws a distinction by placing its focus on the market structure to gauge market performance. Support is found in studies that look at market performance as a function of profitability to traders (Mumbeya, 2012), access to the market by the farmer (Zeller, Diagne, & Mataya, 1998), and greater emphasis on competition along with consumers (Chan *et al.*, 2003).

Other bodies in literature study market performance based on value chains by using components of the value chain and ignoring non-cost components in the value chain (De Toni & Tonchia, 2001). The main setback of this approach in the literature is the failure to connect with the entire value chain as a system offering no systematic view of the value chains. This is because market chains that need to be measured at multiple levels cannot be effectively measured by using single components.

From a different perspective, market performance can be measured by quantifying the effectiveness and efficiency of the action (Neely, 1999). Effectiveness dwells at the level and degree to which the client's needs are achieved, and efficiency focuses on the economic benefits of the supply chain to the actors in the chain.

Value chain performance is sometimes assessed on an individual level in systems and through the relationship of the value chain with the environment it operates in (Neely, 1999). Lee (2004) separates measurement according to the process of the business. This is done by separating the appropriate processes at a tactical, strategic and operational level, and amongst cost and costless measures. Costless measures include time, value, flexibility, and the ability to come up with new ideas. Reliance only on costs in indicators may bring about the false depiction of the performance of the market chain, which makes such a distinction very important. Time and quality measurement of the supply chain shows its capability to bring about high customer service, while flexibility and origination reflect the capability to adapt to and handle swift fluctuations in demand and supply.

Lastly, strategic research studies the synchronisation of the value chain with the strategic objectives of the actor (Balasubramanian & Gupta, 2005). These strategic studies put more emphasis on the adoption of a systemic approach to measure performance.

Taking into account the above-mentioned deliberations, the competence of the maize marketing chain or value chain will be examined in this research based on how the maize market achieves the preferences of the actors in it, and how the value chain influences the price formation process. In a good market environment, the value chain ensures that consumers receive fair prices, while simultaneously allowing producers to also achieve fair prices. This value chain furthermore ensures that, at the market place, supply and demand balances at any time in each segment. Such a significant look at the maize value chain of Eswatini has not been published and this study will provide a base for future studies of the maize value chain.

3.3. ESWATINI MAIZE VALUE CHAIN ANALYSIS

Eswatini's maize marketing chain is quite disaggregated and disorganised. This was graphically illustrated earlier in Figure 2.1, Section 2.4, Chapter 2. The situation can still improve, inasmuch as the current situation works against most of the actors in the value chain. It can improve, as most of the factors needed for improvement and potential success are known, even though they are not yet well established in the country. For example, market information, farming knowledge and technologies, and good performing varieties of seeds are all available, but what is needed is that these factors are distributed and applied in a way that ensures a profit for the actors in the value chain. Better results for this can best be achieved by empowering the private sector, enabling it to lead the development of effective and efficient value chains. Furthermore, a realistic and practical approach must be employed in trying to do so, which approach must be based on comprehension of the current situation.

Due to the country's need for maize and high dependence on maize imports to fill the gap in demand, a creative-critical review has to be done to identify key improvements in the value chain that can be made. These improvements can be specific to maize and some can be general, dealing with the removal of blocks to the development of the environment that the value chain exists in. All actors must be willing to cooperate to bring about change and development to the value chain, as it will not be easy to accomplish.

3.3.1. Maize value chain actors

Maize is a major part of the farming system in Eswatini, and as mentioned earlier in Chapters 1 and 2, it is the staple food of the country. Several actors are involved in its value addition, which ranges mainly from production to consumption. Common final products of maize in Eswatini are mealie meal, stamp, and mealie rice and flour. Other products include roasted mealies, boiled mealies and mealie bread made from green maize. However, by far the majority of maize is processed into mealie meal.

3.3.1.1. Producers

Maize production takes place in all regions of the country, with the production in the Highveld being the highest due to the region's high rainfall. Furthermore, almost every household in the country produces maize. Most of the production from households is subsistence and the surplus is sold to either the formal or the informal market streams. Varieties opted for by farmers are those that are common in a specific year and highly advertised to be the best performing. All the varieties used are open-pollinated (OPVs). The use of GMOs is currently banned in Eswatini. However, most of the time, farmers use home-saved seeds rather than buying fresh seeds every season, which brings down the harvest yields after several seasons of cultivation. This is a very common tendency among small-scale or rural farmers.

After harvest, farmers transport their maize to the NMC's silos located in all regions of the country. Small-scale or rural farmers will only sell surplus maize, while medium-scale farmers not only produce for home consumption, but also for selling. As individuals, small-scale farmers (mostly rural farmers) sell their surplus produce at the farm gate. Small-scale farmers also sell their maize to small-scale or rural millers and rural traders, although this is not a common practice. Medium-scale maize producers and large-scale or commercial maize farmers mostly sell their produce to the NMC and/or medium-scale millers. Maize is sold to the NMC at the various silos. As at 2018, the price for buying maize from a local farmer was E2 600.00 (NMC, 2018).

National maize production has been estimated at around 113 039 metric tonnes from a planted area of 80 965 hectares, as shown in Table 3.2, and about 9 074 metric tonnes were sold to the NMC by small-scale producers for the year 2018, as depicted in Table 3.1 (Early warning unit, 2018).

Table 3.1 Local maize purchases (2018) (MT)

MONTH	LOCAL MAIZE PURCHASES (MT)
April	171
May	235
June	2 200
July	4 714
August	1 039
September	382
October	128
November	77
December	22
January	67
February	14
March	26
Total	**9 074**

Source: NMC, 2018

Table 3.2 Local maize purchases, the area planted, production and sales (2018) (MT)

YEAR	AREA PLANTED	PRODUCTION	NMC LOCAL PURCHASES	IMPORT REQUIREMENTS	NMC MAIZE SALES
2013/14	86 754	101 041	4 619	15 704	20 323
2014/15	87 164	81 623	2 390	29 584	31 974
2015/16	46 040	33 460	6 341	27 649[7]	33 990
2016/17	69 932	84 344	1 586	45 428	47 014
2017/18	80 965	113 039	9 074	22 925	31 999

Source: NMC, 2018

[7] The drop in area planted in 2015/16 only caused imports to increase in the following year.

3.3.1.2. Local traders (whole maize and maize meal)

Local traders can be divided into two dominant groups, i.e. urban traders comprised mostly of supermarkets and some wholesalers, and rural traders comprising mostly grocery stores. Rural traders usually buy grain from rural producers during harvest season, selling it back to rural consumers, mostly in the form of mealie meal sourced from urban traders and millers. Although prices vary from producer to producer, rural traders target harvest time when prices are low and large amounts of maize are available to be dealt with. Urban traders, on the other hand, rarely trade in maize grain and instead trade mealie meal that is sourced from urban or medium-scale millers, which they sell to consumers and rural traders. The urban trader market is relatively concentrated, with some national chain stores leading the market. The top major players in the urban trader industry include Pick ’n Pay, Shoprite, Boxer, Spar, and Checkers.

3.3.1.3. The NMC

The NMC plays a vital role in the value chain of Eswatini. The NMC buys maize from local producers and sells it to millers and end consumers. Buying maize is made easy by the locating of regional silos that the NMC has done within the country. Producers bring their produce for sale to the NMC at these silos. It makes it easier for producers to sell to the NMC as they can simply access the closest depot rather than transporting their produce to the main silo and headquarters of the NMC. The NMC only buys maize from producers at these silos and does not sell maize from these silos, except at the main silo in Matsapha where the headquarters are. The buying price is the same at all locations and silos – E2 600 in 2018. The maximum capacity of the maize silos, combined, is 23 500 metric tons. The various capacities per silo are summarised in Table 3.3 below:

Table 3.3 Countrywide silos and distance from the main silo

REGION	DEPOT	CAPACITY (TONS)	DISTANCE FROM MAIN SILO (NMC)
Manzini	Matsapha	20 000	0
Manzini	Ngwempisi	700	36
Hhohho	Nftonjeni	1 400	116
Lubombo	KaLanga	700	64
Shiselweni	Madulini	700	90
	TOTAL	**23 500**	

Source: NMC, 2018

The Matsapha silo is the main silo and the largest of all silos. It is where the maize is sold, as the other silos operate as collection points and extra storage. It operates all year round, along with the Ngwempisi Depot and the Madulini Depot. The other two depots, Kalanga Depot and Ntfonjeni Depot, operate seasonally. A total of 9 074 metric tons was collected from all depots in 2018, as shown in Table 3.4 below:

Table 3.4 Depot collections (2018) (MT)

Year	Matsapha	Ngwempisi Depot	Nftonjeni Depot	KaLanga Depot	Madulini Depot	Total
2016/17	1 413	173	0	0	0	1 586
2017/18	3 646	1 752	979	214	2 483	9 074

Source: NMC, 2018

3.3.1.4. Millers

Eswatini has small- and medium-scale millers. Small-scale millers are found in the rural areas and receive most of their maize from rural surplus producers. Rural millers rarely buy maize to resell later, but rather process maize grain that is brought to them by local farmers or customers, at around E7 per 20kg. Mostly, they keep the bran to resell later as animal feed. Medium-scale millers, on the other hand, are mostly found in the urban areas around the industrial district in Matsapha, close to the NMC. These millers buy maize from the NMC or producers at almost the same price, which was more or less around E3 500 per ton in 2018. Most of Eswatini's white maize processing is done by medium-scale millers and their products are sold to urban traders, rural traders and the public.

Millers in Eswatini mostly process maize under dry milling, where the maize kernels are refined to maize meal. They process maize mainly to produce mealie meal and, on requests mostly received from the public, to produce samp and mealie rice. Some of the maize produced is also sold as green maize, which is mostly sold in the urban areas as roasted mealies and boiled mealies, and is also processed into mealie bread. Wet milling is not done in Eswatini.

The maize value chain of Eswatini is depicted in **Figure 3.1**. As mentioned in Chapter 2, there are four formal medium-scale millers in Eswatini, namely Universal Milling, Ngwane Mills Ltd, Dalcrue Holdings and Nkoyeni Milling. Ngwane Mills Ltd and Universal Milling Ltd hold 60 per cent and 20 per cent, respectively, of the market share, dominating the milling industry in the country (JADAFA, 2014).

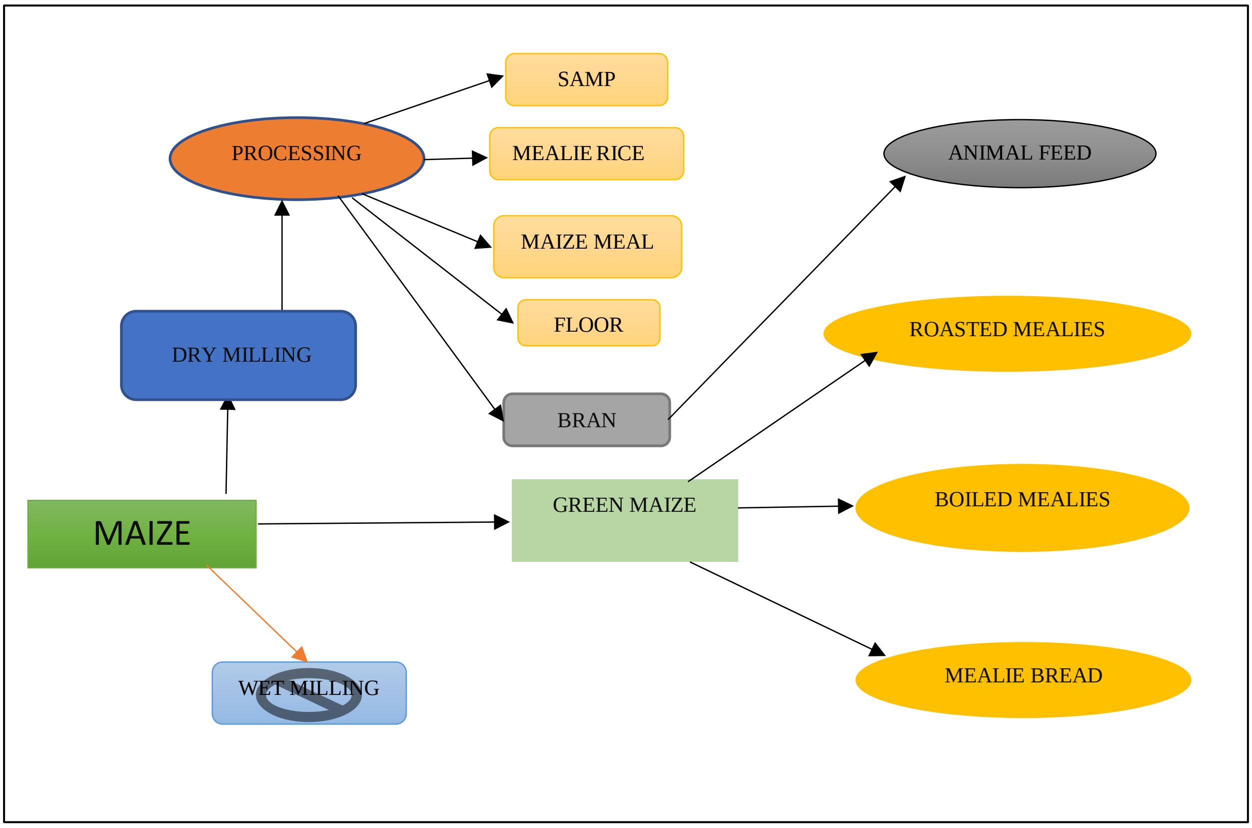

Figure 3.1 Eswatini maize value chain tree (2020)

Source: NMC (2018) and own data (2020).

3.3.1.5. Maize imports

Maize imports fill up the gap that is left by the local supply. Imports are not fixed but vary depending on the performance of local production, i.e. if local supply falls short, greater amounts are imported, and *vice versa*. In the year 2018, imports amounted to 22 475 metric tonnes, a decrease of 48 per cent as compared with 2017's amount of maize imports of 43 317 metric tonnes (Figure 3.2). This decrease in imports can be attributed to the El Nina climate phenomenon experienced from 2015 to 2017, which forced most producers and households to depend on buying maize rather than on production for self-sufficiency. This was later followed by a La Nina, which resulted in fewer imports, since it presented abundant rainfall, resulting in positive yields locally (NMC, 2018).

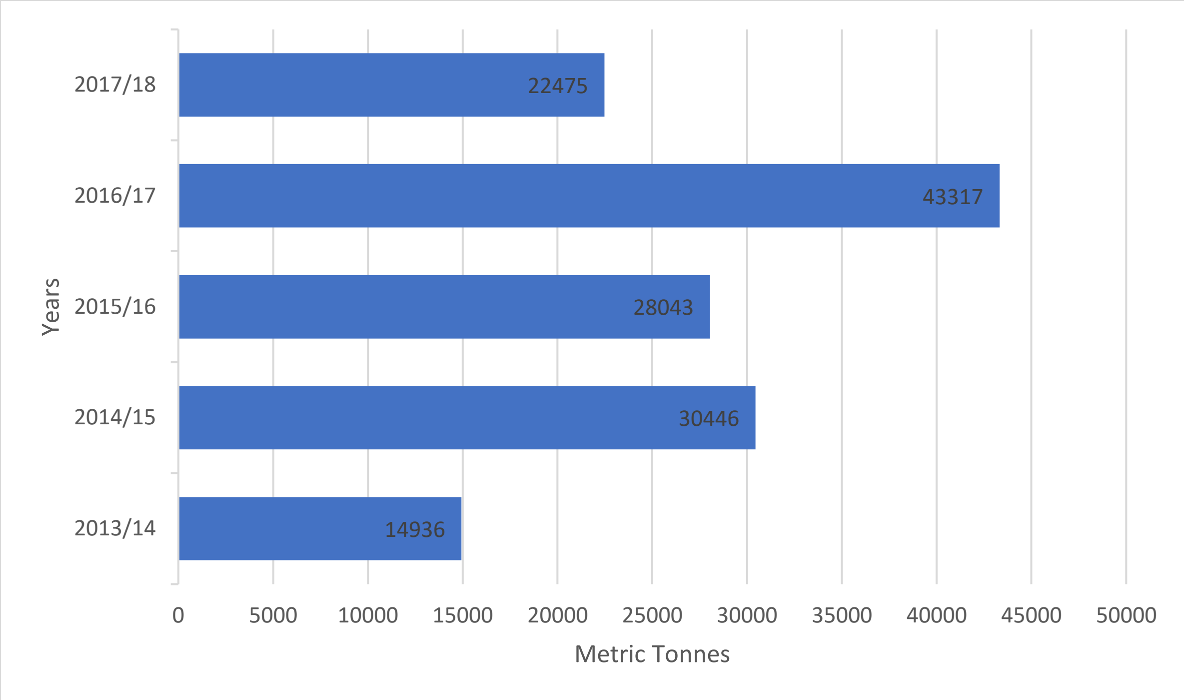

Figure 3.2 Maize imports (2013 to 2018) (MT)

Source: NMC, 2018

The NMC imports from South Africa through Rand-Agri and COMDI. They use the SAFEX buying price available at that point and this price is also what the NMC is expected to use when buying (locally at least). This means that, if the SAFEX price is higher than the local buying price, the NMC will buy maize from local producers at the same rate as that obtained from SAFEX. South Africa exports maize to Eswatini under SACU at an Intra SACU rate of 0% (Department of Agriculture, 2018)

3.3.1.6. Consumers

Consumers mostly buy mealie meal from either urban or rural traders. Urban consumers will entirely source their mealie meal from urban traders. Rural consumers buy mealie meal either from urban traders or rural traders. Consumers also choose to buy maize grain either from producers and traders, mostly common with rural traders and consumers, or the NMC, which urban consumers prefer. They then take this maize grain to millers for processing to mostly mealie meal, and other maize products of their choice.

3.4. CONCLUSION

There is little to no integration between actors in the value chain and each actor works independently of the other actors for his or her own benefit. This presents many possibilities for opportunistic behaviour to those with much power or a bigger share in the chain, thereby leading to inefficiencies in the chain. What can also be seen from the value chain is that the Eswatini maize industry remains largely controlled, and much has to be done to achieve a liberated market. Competition is not harsh, other than for farmers selling in the informal sector. Monopoly rules the formal sector through the NMC, as the NMC is the only authority that can import maize into the country and, through the government, exerts a certain control over the local maize market. This disrupts the value chain too. This is a disruption since the NMC, alongside the government, affects the price formation process. Forces of demand and supply now play a smaller role in price formation, compared with how they should do in a good competitive market. Information flow between actors in the chain is not free-flowing from one actor to the next due to their independency on each other, and this also brings inefficiency to the value chain. Improvements can be made, but these will have to start in the environment in which the value chain works, and especially the policy environment.

CHAPTER 4 LITERATURE REVIEW

4.1. INTRODUCTION

Chapter 4 looks at the observed discoveries and concepts on price transmission and market integration, as well as hedging, previously reported by researchers. Analysing these studies in depth will assist in determining which methodological approach will work best when studying the price transmission between South African and Eswatini white maize prices. The literature review will also provide guidance, allowing for a better understanding of the econometric methods and models discussed in Chapter 5 of this study. This chapter not only focuses on studies conducted in South Africa and Eswatini, but also on numerous other studies conducted in a number of countries and different commodities.

4.2. PRICE TRANSMISSION

4.2.1. Theories on Price Transmission

Price transmission, price relationship or price correlation analysis measures the effect that one market's prices have on the prices in another market (Mokumako & Baliyan, 2016). It examines the co-movement depicted by prices of homogeneous or similar goods in different geological markets (Listorti, 2009). Price transmission can be measured through transmission elasticity, i.e. a percentage alteration of prices to another market, given a 1 per cent alteration of prices from the other market (Minot, 2010[b]). The transmission of the price is either vertical or horizontal. Vertical price transmission describes how price changes (degree of adjustment and speed) are transferred within the market chain or supply chain (Abdulai, 2000), in other words, referring to relations among prices at different supply chain points. Comparatively, horizontal price transmission (spatial price transmission) discusses how domestic prices adjust to international or cross-border prices, or how prices are related between spatially separated markets within a country (Abdulai, 2000).

According to the Law of One Price (LOOP), price transmission abides by the spatial arbitrage condition, i.e. the price of similar commodities in dual, different places will vary by the costs accrued from moving that commodity from a place of origin (low price area) to the destination place (high price area) (Fackler, 2001). Due to indefinite and recognised reasons, price transmission is usually incomplete (Conforti, 2004). This may be due to, among other things: excessive transaction costs brought forward by asymmetric information; transaction costs; negotiation; and search of information costs; as well as supervision and application of contract costs. Inconsistent transaction costs disrupt the spatial arbitrage's benefits and this may lead to the LOOP not holding. Border policies and domestic prices obstruct price communication from world markets and inside the country, respectively. The LOOP can be presented by the following equation:

$$\mathbf{y_t = \beta x_t + c} \quad \textbf{(1)}$$

where y_t represents the price of the excess producing region, x_t represents the scarcity or importing county's price, and c represents the contract costs accrued during the trade. In association with the Equation (1) above, a unitary elasticity assumes complete transmission, with all duties and transport costs proportional to price, and therefore the LOOP holds. Grains and other primary commodities are assumed to have instantaneous transmission, obeying a perfect arbitrage rule. For imports, an elasticity of less than 1 holds for transmission that is perfect, while for exports the opposite is true (Brooks & Melyukhina, 2005).

Price transmission is mostly analysed using time series techniques. The Error Correction Model (ECM), Granger Causality Test, and the Cointegration Test are frequently used techniques in price transmission analysis, falling under the time series umbrella. These methods provide inferences about the links between markets, as well as providing the necessary information on the nature of such markets' relationships. Furthermore, the above-mentioned tests provide information on the speed of adjustment as time moves. This can be used to inform price-transmission-related issues.

Granger introduced the Cointegration Test in 1982. Cointegration exists when series are integrated into a linear combination possessing a stationary error term. This means cointegrated markets will have the changing aspects of the price relationship of the markets converging in the long run. In 1987, Engle and Granger came up with a two-step procedure for cointegration, i.e. the Engle-Granger Cointegration Test. Although the Engle-Granger method is a good tool for studying long-run changes within markets (Engle & Granger, 1987), it only reflects symmetric price transmission and linear series. This makes it inefficient if the thought of non-symmetric price adjustment exists, presented by factors that disrupt efficient market integration transmissions (Balke & Fomby, 1997). This model recognises a single cointegration vector because it only considers two variables.

The Johansen Test is a multivariate procedure that was developed by Johansen in 1988. It determines the number of cointegrating relationships, using a maximum likelihood technique (Stigler, 2010). It is an improvement of the Engle-Granger method since it permits the assessment of multiple variables leading to multiple cointegration vectors, allowing for variables with different orders of integration, which in turn allows for all variables to be tested (Johansen, 1988). Limitations of this approach are that it tests for linear adjustments that assume transaction costs are constant, and like the Engle and Granger technique, completeness of adjustment and co-movement is only tested.

Long-run relationships can be estimated by using cointegration, but deviations can present themselves from this equilibrium state over the short run. Estimating the ECM can help capture the short-run dynamics which make the ECM act as an extension of the cointegration procedure. Short-run estimates can be captured by using the ECM if a long-run relationship has been revealed using the Engle-Granger or Johansson tests. Should a shock happen to one of the variables, the ECM will determine the magnitude and the extent on the domestic price's adjustment in stabilising the relationship between local and international prices (Balcombe, Bailey, & Brooks, 2007). Jaramillo, Yunez-Naude, & Serrano-Cote (2012) state that the effects of one-time series on another, in the short run, can be estimated by using the ECM.

An error correction term is contained within the ECM and it captures the speed of adjustment to equilibrium level. Error Correction residuals in a multivariate setup occur in vectors, which gives them the name of the Vector Error Correction Model (VECM). Estimation of the VECM is done if more than one vector or cointegration relationship is found when using the Johansson Test. The VECM extends the Johansson method. Should a bi-directional connection be expected amongst the variables that are involved in the system, then the VECM approach can be used.

ECM and Cointegration methods have been used in a number of research studies to measure the transmission of prices between international and domestic markets. Different links are provided by such studies between the world and local markets. Set out below are some of the prominent studies that employed time series econometric methods in the analysis of spatial price transmission.

4.2.2. Empirical Studies

Several authors have tackled price transmission within the framework of market integration along with the LOOP. Abidoye & Labuschagne (2014) studied world transmission and co-movement to local prices in countries of Sub-Saharan Africa, where a comparison of nested transmission of maize prices to Botswana from South Africa and non-nested models capable of capturing non-similar systems of non-linearity in the price spread were used. The Bayesian method was adopted in their study since the Bayesian approach utilises the Bayes Factor, which allows for the comparison of models. Threshold effects were reportedly found to exist. This means that the transmission of international prices to local South African markets does not happen if the changes are small. Another conclusion of the study was that huge deviations in price, in the long run, are transmitted and nearly 98 per cent of the dissimilarity in international prices transmits to maize prices in South Africa, sooner or later (Abidoye & Labuschagne, 2014).

Levels of transmission of world market price changes, for four agricultural products, to domestic producer prices in Tanzania were evaluated by Kilima (2006). These four products comprised cotton, rice, wheat and sugar, and the observation was done over the period 1994 to 2005. Imperfect price transmission was found between Tanzanian prices and world market prices after the Cointegration and Causality methods were employed in the testing of linkages in prices. On the other hand, a unidirectional causal relationship was discovered to be present, employing the Granger-Causality test, thus showing effects of world commodity prices on Tanzanian local commodity prices. Some shocks from international markets, as concluded from the results, passed through to local markets in Tanzania, despite the drifting apart of international commodity prices and local prices in Tanzania (Kilima, 2006).

The Vector Auto-Regressive (VAR) model was employed by Kaspersen & Føyn (2010) in their study of price transmission between international markets and that of the Ugandan local markets for sorghum and Robusta coffee. Weekly market prices from 1999 to 2008 were used for sorghum, and monthly producer prices from January 1977 to April 2006 for Robusta coffee. Outcomes revealed that integration was not found between sorghum prices in Uganda and world markets, and that sorghum price transmission within the country was fuelled by oil prices. Ugandan prices were connected strongly to world prices in the case of Robusta coffee, independently of oil prices (Kaspersen & Føyn, 2010).

In a much broader study, Minot (2010[a]) investigated the transmission of fluctuations in international food prices to African markets as well as its effects on the well-being of African households. Nine countries and their price relationships with world prices were studied over a five-year period, using the VECM. These countries comprised Uganda, Zambia, South Africa, Tanzania, Malawi, Mozambique, Kenya, Ghana, and Ethiopia. Only 13 out of 62 domestic price series for wheat, maize, and rice, which were used for data, showed or displayed a relationship in the long run where international prices affected domestic prices of the same commodity. Only 6 out of the 13 had a statistically significant long-term elasticity of transmission (Minot, 2010[a]) This is on the low side, a higher number is more desirable and will be sign of an open efficient market economy.

Using the Threshold Auto-Regressive (TAR) model and monthly regional wholesale price data from 2002 to 2010, Ankamah-Yeboah (2012) evaluated the movement of the price of maize markets in Ghana. Market pairs in both the short run and the long run showed bidirectional market interdependence concerning negative and positive shocks. Long-run causality, however, was found to be heterogeneous. With a time path ranging from 7 to 26 months, asymmetry of price adjustment was found, with a quick response from traders when market margins were squeezed, compared with when they were stretched for all market pairs (Ankamah-Yeboah, 2012).

Alejandro (2012) used an Asymmetric Error Correction Model (AECM) to test for spatial price transmission of white maize prices between South Africa and Mozambique. The study found that cointegration in the long run, for the movement of white maize prices to Mozambique, existed. This, however, was not the case in the short run. Depending on the upward and downward movements of international prices, the transmission of these prices was asymmetric. Barriers that were found to obstruct further effective price transmission were linked to the value-added tax structure and the presence of a highly prohibitive import tariff. Alejandro (2012) concluded that the application of other econometric models to study such relationships on all the crops would have provided a wider discussion and more accurate results over all the products.

An investigation of the maize price relationship between South Africa and Eswatini was conducted by Dlamini (2017), assuming the absence of pricing and marketing policies that are implemented by the NMC. The price relationship between South Africa and Eswatini, using a scenario where the aforementioned policies from Eswatini were absent, was done to quantify the effects of such policies on the Eswatini maize markets. Secondary data from the NMC and the Ministry of Agriculture, together with that of SAFEX, spanning from 2000 to 2014 was used. Time-series econometric methods, including unit root test and cointegration test, were employed in confirming the study's hypothesis of the existence of a long-run price relationship among South Africa and Eswatini maize markets when such policies are absent.

This research study, on the other hand, will focus on one string of data, being monthly secondary data collected from the NMC from the operational years 2008/2009 to 2018/2019, together with that of SAFEX prices for the same years. Data from the Ministry of Agriculture will not be used in this study since it does not include management and transaction costs incurred by the NMC, which play a role in assessing the final prices used by the NMC. Compared with the aforementioned study, this research study will use the latest price data from the NMC under the present marketing structure, with no adjustments and scenarios in policies.

Using the latest price data (2019 backward) to analyse the relationship between South African and Eswatini prices can better help in finding the latest relationship statistics and facilitate providing a future forecast. This can provide the latest information for deciding whether the country of Eswatini can hedge its price risk by using SAFEX, or not.

4.3. HEDGING

Commodity derivatives instruments (such as options, futures, and swaps) have had much appeal in dealing with price uncertainty due to market liberalisation (Varangis, 1999). Price risk and price risk management have evolved drastically in the commodity sub-sector due to commodity market liberalisation. The private sectors and governments of developing countries have increasingly come to use commodity derivative instruments. The knowledge and ability to make full and proper use of these price risk management and financing tools by the private sector will ensure the survival and success of market reform (Varangis, 1999).

A futures contract can be defined as a legal agreement to supply or accept a given standard or amount, at a certain future date, of a product at a decided price. Contract transactions differ from futures contracts in that price determination happens only when the product is offered (Van der Vyver & Van Zyl, 1989). Negotiability draws the line between futures and forward contracts.

Parties enter into a forward contract when a product is sold to the buyer, usually at a predetermined quantity. Price stipulations differ on the type of contract (Van der Vyver & Van Zyl, 1989), and are non-negotiable, and legal implications may result if the contract is not honoured. One can be released from any obligations by engaging in an opposite or similar transaction, notwithstanding that the existing legal agreement is in place. Transference of price risk, associated with growing maize, to a professional speculator can be done through the futures market. Studies have been done when it comes to hedging price risk, especially on the buyer’s (millers) side, but in this dissertation, only a few hedging strategies are discussed.

4.3.1. Price Establishment

Two separately functioning, but closely related, markets have to be kept in mind when tackling the process of price establishment, i.e. the futures market and the cash (spot) market. The futures market trades in maize contracts for future delivery. These contracts are standardised, i.e. the buyer agrees to buy the asset (maize) from the seller. Quality and quantity are used to itemise the commodity, and predetermination of the price for future delivery is done (Madura, 2006). Commodity exchange institutionalises the trading system, where individual future maize contracts are specified (Josef Tauser, 2014). In the spot market, trading and handling of a commodity are done physically, and farmers or producers use intermediary companies to sell their grain.

The coexistence of these two markets makes it difficult to decide on the most relevant market for either the miller or the producer. The price in the spot market is determined by the futures price, making both markets equally important (Josef Tauser, 2014). The formula below states that the correlation between the futures price and local cash price is positive:

$$\boldsymbol{Local\ basis = futures\ price - local\ cash\ price} \qquad \textbf{(2)}$$

The basis, on the other hand, can either be positive or negative and can be calculated as the difference between the two prices (as stated by the formula above), and reflects local market situations, depending on several factors such as transportation costs, storage costs, handling costs, profit margins, and supply and demand conditions. The basis weakens and strengthens as it becomes more negative or more positive, respectively. Both the buyer and producer are informed by the basis value on how to trade using both markets or using options and futures strategies to hedge (Tauser, 2014). Van Der Vyver (2019) explains the basis as the combination of the premium and location differential and that it incorporates all regional or local supply and demand factors at a specific time in the season.

4.3.2. Hedging with Futures Contracts

Hedging agricultural commodities, compared with other assets, is more or less similar, although specific to some extent. Farmers use contracts to lock-in the selling price by hedging with customers when buyers are limited in number, and the same goes for millers when considering whom to buy from. Hedging tools, like futures, options and forwards, also serve as selling mechanisms, and have grown in popularity over the years (Irwin & Sanders, 2012). Both producers of maize and millers can protect themselves against adverse price changes in the future, i.e. price decreases for producers and increases for millers, by hedging. Producers can sell maize futures and millers can buy maize futures, locking-in the selling price and buying price, respectively. This aids as a temporal substitute for buying and selling in the spot market since the physical delivery of maize is postponed on the spot market (Tauser, 2014). An opposite position to the spot market is occupied by the farmer or miller when using the futures market.

4.3.3. Hedging with Forwarding Contracts

The key advantage of forwarding contracts is the fixing of most of its key features as well as the personalisation of a client's needs. Forward contracts are characterised by non-deliverability, meaning that after the expiration of the contract, only differences in prices are settled and no physical delivery of the commodity takes place. The difference in price is calculated from the closing price, which is usually the spot market price and the agreed price by the client on the date, and the party in the disadvantageous position must pay what is owed after calculations have been done. The farmer receives the difference in prices if the local cash price drops below the fixed price, but has to settle the variance if the local cash price surpasses the fixed price. Thus, the farmer is protected against a price drop but has to pay if prices go up, and this can be labelled as the cost of hedging (Irwin & Sanders, 2012).

4.3.4. Hedging with Options

Slightly different from the futures and forward contracts are Options. Still part of the derivatives family, options provide a certain type of flexibility. The right, but not the obligation, to sell or purchase a product at a specified value and a specified period is the security given by an option (Scholes, 1973). Two types of options exist and are commonly used, i.e. the American options and the European options. The difference between these options arises in the execution date. The American option may be exercised at any time, whereas the European option may only be exercised at a specified date in the future. The 'striking' price is paid for the asset or commodity when the option is exercised, and the last day to do so is called the maturity date. Spreads[8] are possible for investors because of certain mechanisms of options (Geyser & Cutts, 2007).

A distinction can furthermore be made between a call option and a put option. Through a call, the buyer of the option gets the right, but not the obligation, to use a specific price in buying the causal futures contract (Hull, 2012). When exercised, the call option buyer receives an underlying long futures position and the call option seller is assigned an underlying short futures position. Using a specified price, the option buyer can sell the futures contract through a put. When exercised, a put option buyer receives an underlying short futures position and the put option seller is assigned an underlying long futures position. Upfront limited costs give the options hedge the advantage, but a high bid-ask spread can, unfortunately, balance this advantage (Dana, Gilbert, & Shim, 2006).

4.3.5. Advantages and Disadvantages of Hedging

According to Bernstein (2000), there are advantages and disadvantages of hedging and the process involved. An advantage of making use of hedging is the possibility of locking in the price of the commodity for both the buyer and the seller. This provides the hedger with the opportunity to plan and know in advance what his profit or loss from the transaction will be. On the other hand, there is a disadvantage to locking in costs or profit if a hedger takes a futures position too soon, i.e. the hedger could limit his/her profit potential. Fortunately, due to the standardisation of futures contracts, a hedger could close out his/her position at any time before the delivery date of the futures agreement (Krugel, 2003). Highly sensitive costs, like financing, transport and storage costs, cannot be evaded, however, by using these hedging instruments alone (Dana *et al.*, 2006).

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8 Spreads can be defined as the flexibility to hedge adverse market exposures and market speculation.

4.4. CONCLUSION

Market integration reflects price transmission. Inefficiencies of markets in price movements allow for arbitrage opportunities to be taken to generate profit, resulting in market prices in two different places differing by more than just transportation costs (Fackler, 2001). Transaction costs, as well as policies regarding trade between the two markets, can be some of the contributing factors too.

Measuring the relationship between two spatially separated markets can be done efficiently by using the time series method, as proven by the studies discussed earlier in Chapter 4. Techniques under time series, i.e. the Cointegration Test and ECM models, have been widely employed in studying price transmission. With price transmission analysis evolving, these methods have become more sophisticated to cater for non-linearities presented by state rules and transaction costs.

Commodity derivatives instruments (such as options, futures, and swaps) has much appeal in dealing with price uncertainty attributed to market liberalisation (Varangis, 1999). The use of such instruments has gained the appreciation of many governments and private sectors for evading price risks or to profit from them. Commodity market liberalisation has brought much change in price risk and management. Understanding such tools and the proper way of how to use these tools in price risk management can ultimately provide sustenance and keep the markets reforming positively.

CHAPTER 5 METHODOLOGY

5.1. INTRODUCTION

The techniques that were used to determine price transmission between Eswatini maize prices and the South African SAFEX prices are stated and explained in Chapter 5. In this chapter, an outline of the time series approaches that were employed in studying price transmission is described. These time series econometric methods help in explaining the connection and relationship among international prices (South Africa) and local prices (Eswatini) of white maize prices intensively, given the price data as obtained from the NMC for Eswatini and from SAFEX for South Africa.

This chapter firstly discusses the data sources used for this research study and thereafter the study area is explained. Data analysis methods described include the Unit Root Test, Engle-Granger Test, ECM, and the AECM. The last part of this chapter provides a summary of the methodological approach, after which some concluding remarks are made.

5.2. DATA SOURCES

For Eswatini, data was obtained from the NMC Head Office in Matsapha. The data covers the years from 2008 to 2019 and was used for this research study. The reason for this short time in the data series is due to regulations as imposed by the NMC. Since the NMC is the only formal institution collecting data, it is the only data that was available for Eswatini maize prices. The price data provided by the NMC is composed of buying and selling prices. International prices, South African in this case, were sourced from SAFEX through the JSE's website. The NMC selling prices and SAFEX's average closing prices were used to represent domestic and world prices, respectively. The NMC buying price could not be used for the study since these prices are subsidised and could, therefore, present difficulties in determining and explaining the price relationship between South Africa and Eswatini. A summary of the data sources and price formation is shown in Table 5.1.

Table 5.1 Prices, price formation and data sources

Prices	Price Formation	Source
Eswatini selling price	NMC selling price	NMC
South African monthly closing price	Average daily closing price as quoted on SAFEX	JSE website

5.3. STUDY AREA

As mentioned earlier in this chapter, the range from 2008 to 2019 of SAFEX average closing prices and Eswatini selling prices was used for the purposes of this research study. Eswatini imports the deficit in its local supply predominantly from South Africa through the NMC, which is why Randfontein, South Africa (the SAFEX reference point) was chosen to represent world prices, and Matsapha, Eswatini, to represent domestic/local prices. Imports in the discussion only include those imported by the NMC to cover the local short supply in response to demand, and do not include food aid.

5.4. DATA ANALYSIS AND METHODS

This chapter discusses the time series methods that were vital in the investigation of the price transmission research study. As mentioned in Section 5.1, time-series methods have remained useful for studying price transmission and market integration, and this means that aspects of price transmission and market integration can be explained or described by using time series methods. A transmission test using the available data (Sections 5.3 and 5.4) and time series methods was carried out, using Eswatini's selling price as the dependent variable and South Africa's (SAFEX) monthly closing price as the independent variable.

5.4.1. Unit Root Test

Unit root testing is important when testing for price transmission due to the time series data in use, since this type of data is usually in levels. This data could be combined in regression analysis, and good, i.e. non-spurious, results are only possible if variables are stationary[9]. The testing of the univariate aspects of the price information, before anything can be further tested using that data, is vital in order to avoid spurious results. This is achieved by determining the order of integration per variable. Stationarity is depicted by an order of integration of zero and non-stationarity is depicted by an order of integration of one or more for each of the variables in question. To achieve a stationary data generating process, differencing has to be done to the variables integrated of order one or more. The estimation of a long-run cointegration process requires that the series of the data used should be integrated of the same order.

The Augmented Dickey-Fuller (ADF) test (Engle & Granger, 1987) is ideal to use to test for the order of integration of each distinct price series. In testing for a unit root, the ADF unit root test was used and is presented in Equation 5-1 below, with a constant and trend.

$$\boldsymbol{\Delta y_t = \alpha + \vartheta T + \beta y_{t-1} + \sum \beta_1 \Delta y_{t-1} + \varepsilon_t} \qquad \textbf{5-1}$$

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

α is the constant term

t is the time trend effect

β is the coefficient on a time trend

T is the time trend

ϑ is the optimal lag value selected based on the Schwartz Information Criterion (SIC)

and:

$H_0 = \beta = 0$

$H_1 = \beta < 0$

9 A variable can be considered to have stationarity if it has no unit root.

If the null hypothesis (H_0) of unit root at level form is rejected, it would indicate that the price series is stationary and differencing would not be needed (Gujarati, 2009).

5.4.2. Cointegration: The Engle-Granger Test

A number of tests are available to test for cointegration. Testing for the integration of the two series is important before testing for the long-run equilibrium relationship between the variables. The Engle-Granger technique is one of the best methods to use when seeking to test for cointegration. A known disadvantage of this method is its inability to consider variables as a system but rather testing for a unidirectional relationship. With the flow in trade being only from South Africa to Eswatini when it comes to white maize, this method can be employed to test for a long-run relationship between these two spatially separated markets. Another important aspect of using this method is setting up the cointegration function, and this should be done properly. To test for Engle-Granger cointegration, the following model can be used (Equation 5-2):

$$\boldsymbol{y_t = a\vartheta + \alpha_1 x_t + \varepsilon_t; \qquad t = 1, 2, 3 \dots \dots n} \qquad \textbf{5-2}$$

where:

y_t is the dependent variable at time $\boldsymbol{t}$

$a\vartheta$ is the constant term

α_1 accounts for the speed of variation in x_t with reference to y_t

x_t is the independent variable in time $\boldsymbol{t}$

ε_t accounts for the random error term (catering for variables that could disturb the association amid the two markets)

Eswatini's white maize price will be the dependent variable denoted by y_t in the model and x_t will stand for the independent variable as South African maize price in the same model. The random error term, also known as the price spread, needs to be stationary (Engle & Granger, 1987).

Therefore, regressing y_t on x_t, as shown in the model above, gives us an estimate of the residual $\Delta\varepsilon_t$, which is verified for unit root as shown in the equation below (Equation 5-3):

$$\boldsymbol{\Delta\varepsilon_t = \rho\varepsilon_{t-1} + \mu_t} \qquad \textbf{5-3}$$

where:

ρ represents the parameter used to determine stationarity or non-stationarity

ε_{t-1} represents the lagged values of order one of the residuals

μ_t represents the errors obtained in filling differenced residuals

To examine for stationarity of a series, the unit root tests are applied on the ε_t and if the residuals are stationary, then that would mean that the two-price series are cointegrated. In other words, it means a price alteration mechanism allowing them to converge to their long-run equilibrium is present.

5.4.3. Error Correction Model (ECM)

Deviations from the long-run relationship, in the short run, are prone to avail and this can be captured through the estimation of an ECM, as compared with the above-mentioned test that captures the long-run features of variables. The ECM allows for the usage of lags of the variable featured in the model and can be presented as in Equation 5-4:

$$\Delta y_t = \alpha + \sigma(y_{t-1} - \lambda x_{t-1}) + \vartheta(x_t - x_{t-1}) + V_t \qquad \textbf{5-4}$$

where:

Δy_t	is the change in the dependent variable over time t
α	is the constant term
σ	captures the rate of adjustment of the local price to its long-run equilibrium adjustment
y_{t-1}	represents the lagged dependent variable
$(y_{t-1} - \lambda x_{t-1})$	is the error correction term which is also the residual estimated from the OLS equation
ϑ	parameter representing short-run dynamics
x_{t-1}	is the parameter representing the lagged independent variable
$(x_t - x_{t-1})$	characteristic "error correction" specification
V_t	is the white noise error term

When y_{t-1} is greater than λx_{t-1}, the speed of adjustment shows a downward correction, and an upward correction when λx_{t-1} is greater than y_{t-1} (Krivonos, 2004). This is why the speed of adjustment must remain at a negative value. Nonlinear adjustments that are not captured by the ECM can be analysed using the Asymmetric Error Correction Model (AECM).

5.4.4. Asymmetric Error Correction Model (AECM)

The AECM analyses nonlinear adjustments to long-run equilibrium. It accounts for positive and negative shocks that could affect the rate of adjustment differently (Granger & Lee, 1989). This is shown in Equation 5-5:

$$\boldsymbol{\Delta_{y_t} = \mu_i + \alpha^+(y_{t-1} - \beta_{x_{t-1}})^+ + \alpha^-(y_{t-1} - \beta_{x_{t-1}})^- + \Sigma_{t=0}^{k}\vartheta\Delta x_{t-i} + \Sigma_{i=0}^{n}\vartheta y_{t-i} + V_t}$$

5-5

where:

$\boldsymbol{\Delta y_t}$	is the change in the dependent variable over time $\boldsymbol{t}$
$\boldsymbol{\mu_i}$	is the constant term
α^+ and α^-	are the error correction coefficients
$\alpha^+(y_{t-1} - \beta_{x_{t-1}})^+$	are divergences reflecting positive disequilibria
$\alpha^-(y_{t-1} - \beta_{x_{t-1}})^-$	are divergences reflecting negative disequilibria
ϑ	parameter denoting short-run transmission elasticity
y_t	is the lagged differenced local price
x_t	is the lagged differenced world price
$\boldsymbol{V_t}$	is the white noise error term

To arrive at a well-specified model that guarantees white noise errors, the lagged differenced local (y_t) and the world (x_t) prices are included. With the AECM, transmission symmetry implies that $\alpha^+ = \alpha^-$, which is the null hypothesis. If the null hypothesis is rejected, it implies the existence of an asymmetric adjustment. An asymmetric adjustment can be caused by negative and positive deviations from the long-run equilibrium amid y_t and x_t. This results in variations in y_t that pose dissimilar magnitudes.

5.5. METHODOLOGICAL APPROACH SUMMARY

A graphical summary is presented in this section of the methodological approach for price transmission analysis (Figure 5.1).

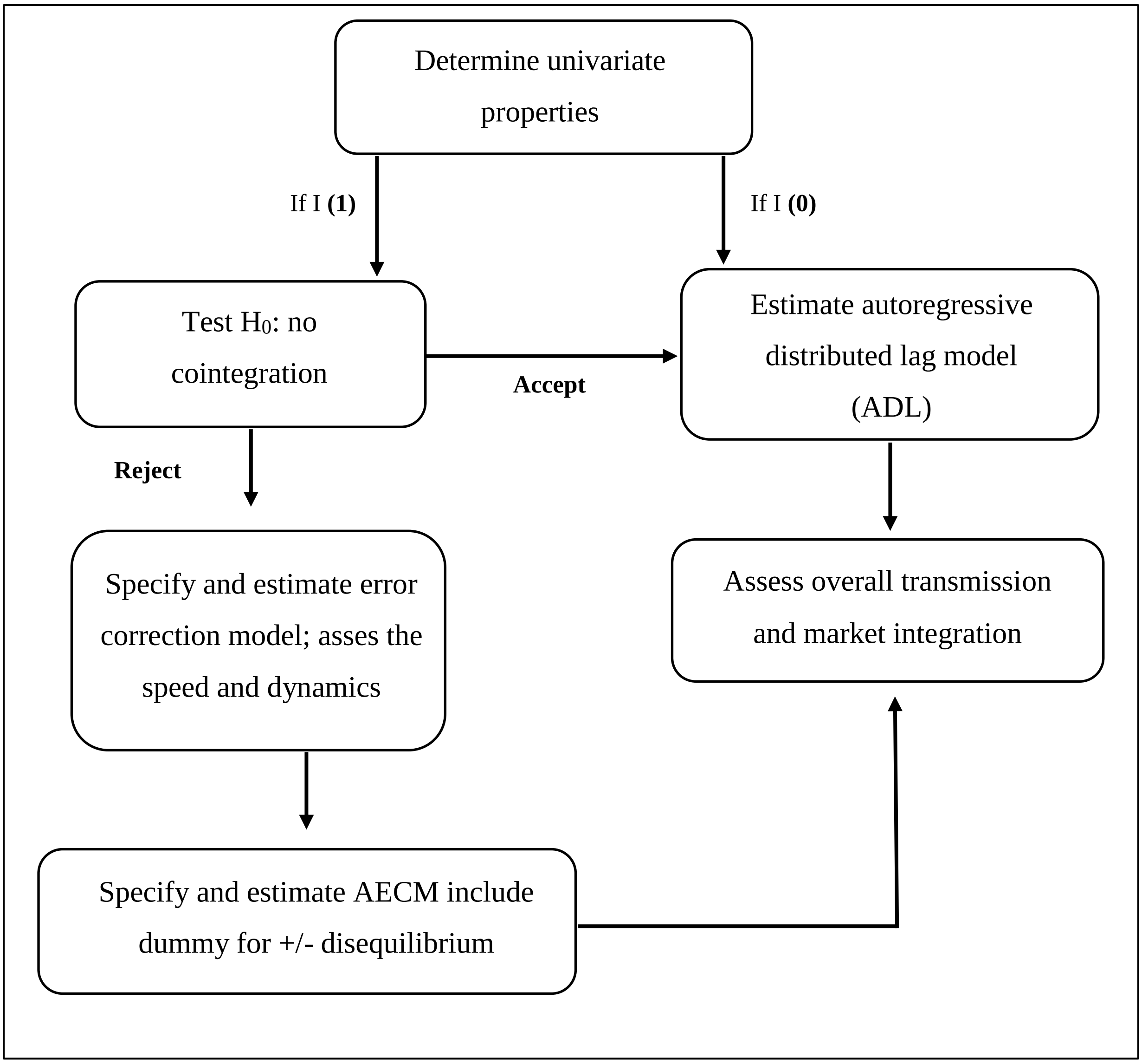


Figure 5.1 Summary of methods used for analysis

Source: (Rapsomanikis & Hallam, 2006)

First, univariate properties of the data to be used are tested to determine their order of integration. If the data is integrated of order one I (1), then we proceed with cointegration. Accepting the null hypothesis of no cointegration allows us to continue with the overall assessment of prices transmission and market integration after estimating the ADL. Should the null hypothesis of cointegration be rejected, it is very important to first specify and estimate error correction model to assess the speed and dynamics, and then specify and estimate AECM including a dummy for +/- disequilibrium before assessing overall transmission and market integration.

5.6. CONCLUSION

Time-series techniques provide suitable ways for measuring the connection between the two markets. They are most fit to measure in detail the relationship between two spatially separated markets. There are several time-series techniques that could be employed in the analysis of the two markets in question in this research study. To ascertain which test is the best suitable for one's analysis requires that one must first test certain properties of the data, i.e. the data generating properties. Time-series techniques may only include an estimation of a regression equation for analysis, but that is disadvantageous since it does not account for dynamic adjustments that might take place between two markets. Such an approach could result in spurious outcomes or results, considering that stationarity of the univariate properties of the variables is not achieved. To avoid spurious results associated with the regression model, the use of cointegration is very important.

Cointegration tests are good for capturing long-run dynamics, and using them alongside the ECM helps to capture the short-run dynamics of the underlined variables. A downside to the cointegration method is that it does not test for nonlinear adjustments, but only linear adjustments, and this can be countered by testing for symmetric adjustment by means of the negative and positive error correction term components. These time series econometric methods assist in assuring that the LOOP of a product in geographically separated markets holds. Chapter 6 covers which method suits the data best and the estimation results of the chosen model.

CHAPTER 6 ESTIMATION AND RESULTS

6.1. INTRODUCTION

The empirical findings of this research study are discussed in this chapter. EViews 9 was chosen as the statistical package to use in revealing the extent of price transmission between South Africa and Eswatini when it comes to maize. Econometric results are shown in this chapter and some of the factors that may affect the price transmission from South Africa to Eswatini are also discussed. Variables were first transformed to natural logs, to reduce skewness, whereupon univariate properties of the data were tested by means of cointegration tests, and then finally the ECM was conducted.

6.2. STATIONARITY TEST

Stationarity was tested by using the ADF test under the null hypothesis of non-stationary (has unit root) against the alternative hypothesis of stationarity (has no unit root). Figure 6.1 and Figure 6.2 respectively show the non-stationary and stationary graphs for Eswatini selling prices (LYESWA), whereas Figure 6.3 and Figure 6.4 respectively show the non-stationary and stationary graphs for South African (LXSA) closing prices. Both sets of prices become stationary after differencing them once. The X-axis is the variation of the prices over the years, which is shown on the Y-axis.

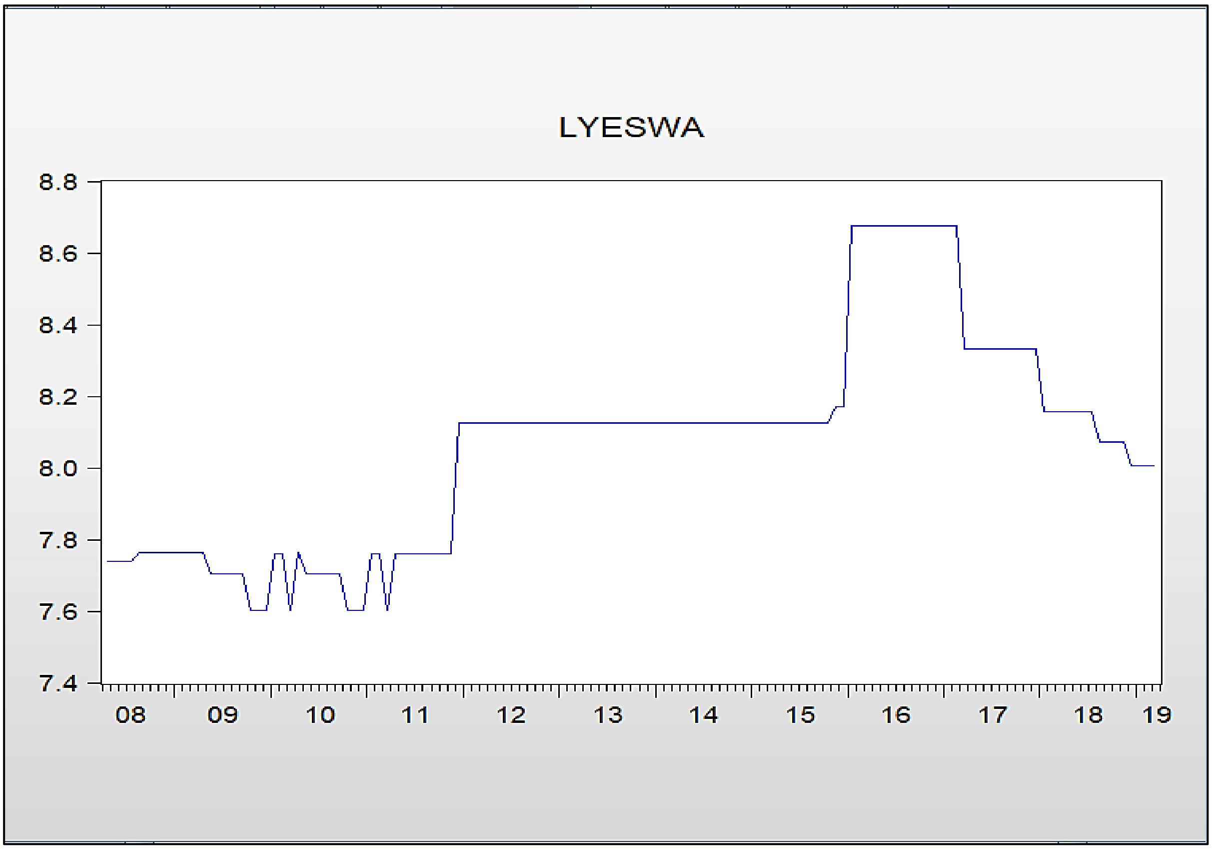


Figure 6.1 Non-stationary Eswatini maize prices graph (LYESWA at I (0))

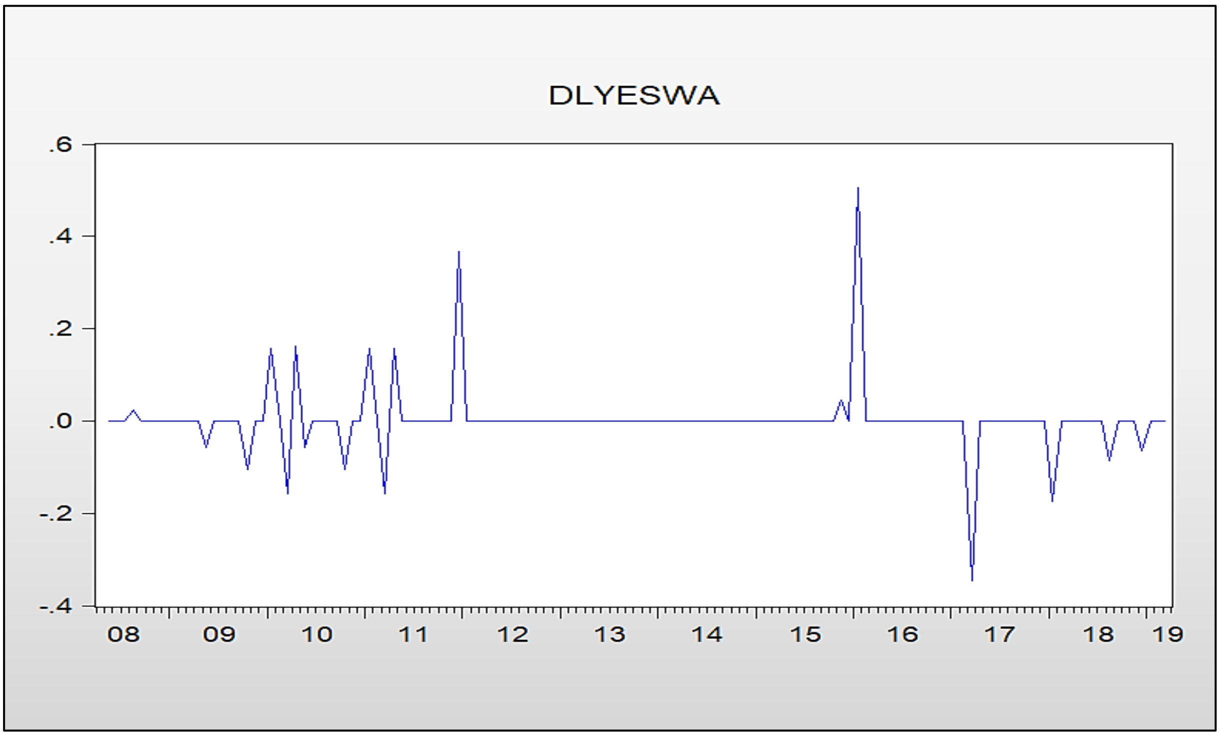


Figure 6.2 Stationary Eswatini maize prices graph (DLYESWA at I (1))

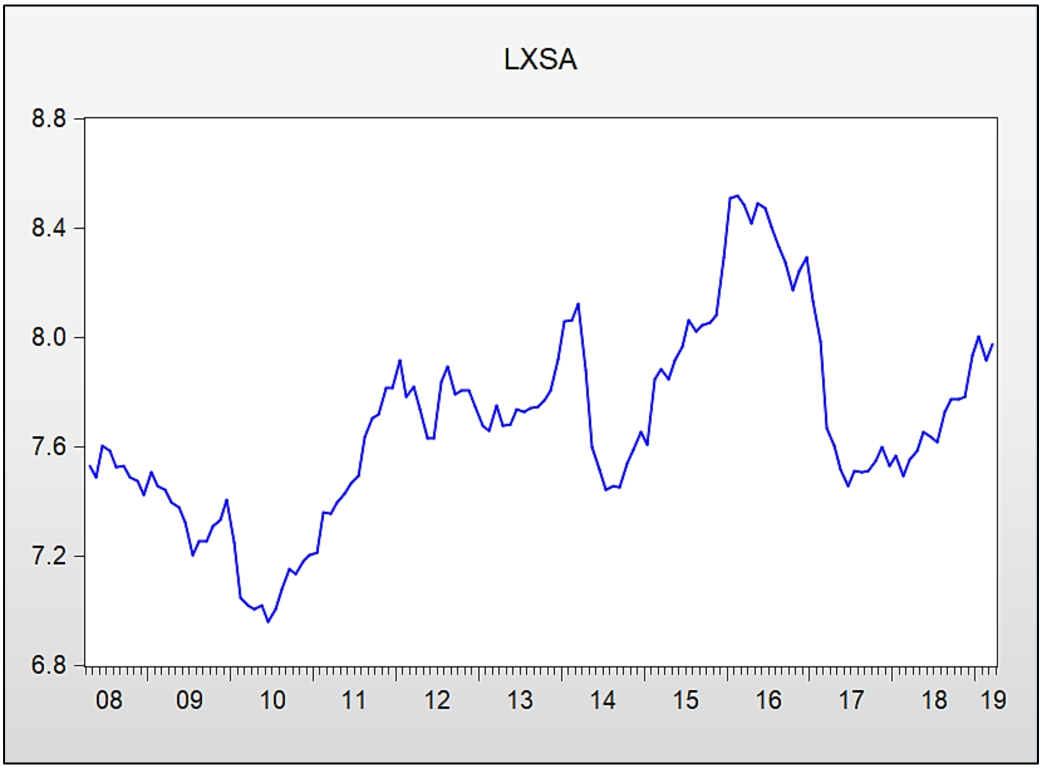


Figure 6.3 Non-stationary South African maize prices graph (LXSA at I (0))

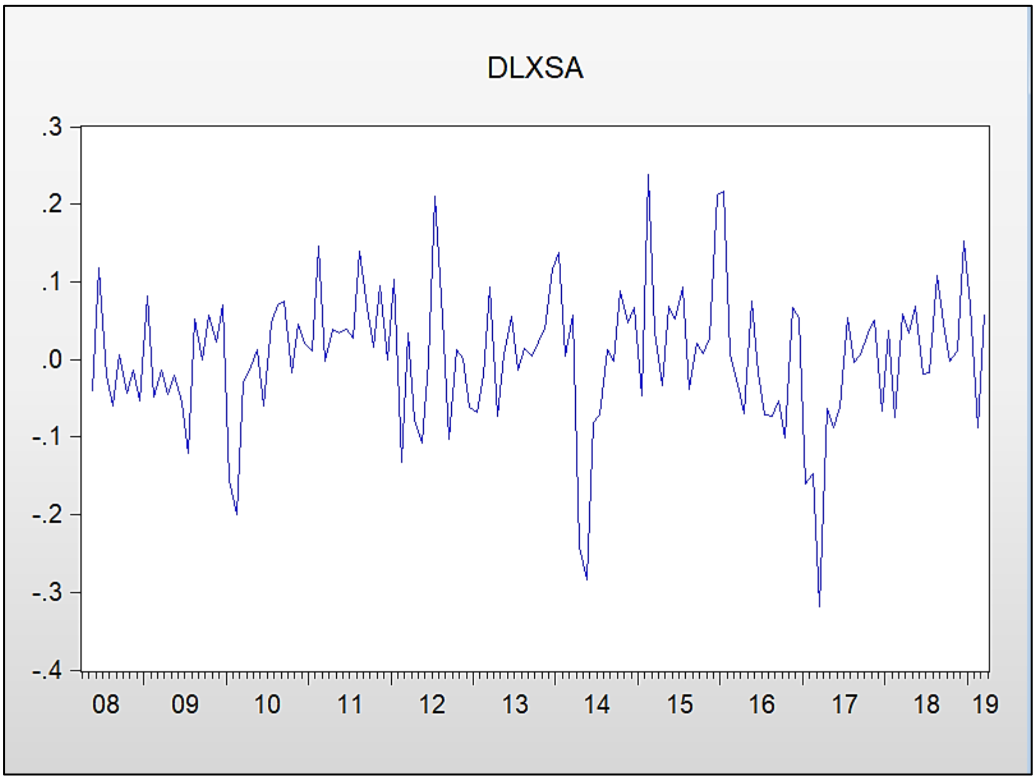


Figure 6.4 Stationary South African prices Graph (DLXSA at I (1))

The results of the ADF test are shown and analysed in Table 6.1 below. Both the Eswatini selling price and the South African closing price series are integrated of order one I (1), which means that these series become stationary when differenced once. This is also supported by the correlograms in Figure 6.5 and Figure **6.6**, which show quick convergence towards zero for the differenced series. These graphs also show differenced series reverting to the mean compared with the level (undifferenced) series. Due to the usage of monthly data, lag 12 was chosen based on the SIC.

Table 6.1 Unit Root Test results[10]

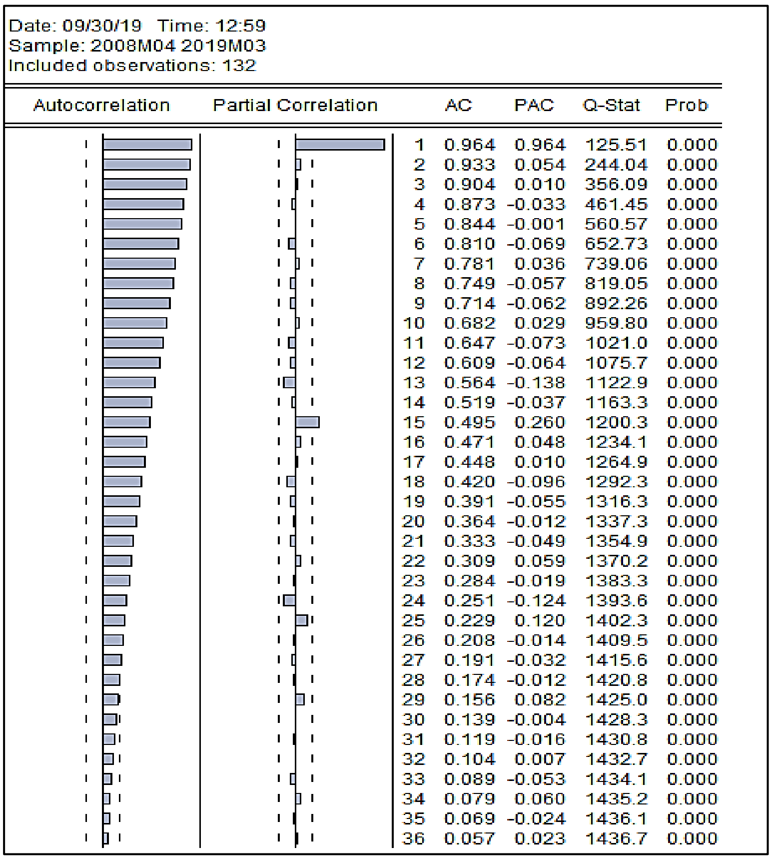
Series	Eswatini selling price		South African closing price	
	Level	**1st Difference**	**Level**	**1st Difference**
ADF t-Statistic	0.251	-12.315	0.305	-8.462
Probability	0.757	0.000	0.773	0.000
Integration order	I (1)		I (1)	

For the Eswatini selling price, the ADF t- Statistic (0.251) is positive and greater than the critical values of -2.583, -1.943 and -1.615 at 1%, 5% and 10% levels of significance, respectively. Therefore, the null hypothesis of unit root at all levels can be rejected for the Eswatini price series. After the first difference, the ADF t-Statistic (-12.315) is more negative than the critical values of -2.583, -1.945 and -1.615 at 1%, 5%, and 10% levels of significance levels, respectively. As a result, the null hypothesis of unit root after the first difference can be rejected, i.e. the series is I (1).

For the South African closing price series, the ADF t-Statistic (0.305) is positive and greater than the critical values of -2.583, -1.943 and -1.615 at 1%, 5%, and 10 % levels of significance, respectively, leading to the failure to reject the null hypothesis of unit root presence at levels. The ADF t-Statistic (-8.462) is more negative (smaller) after the first difference than the critical values of -2.583, -1.943 and -1.615 at 1%,5% and 10% levels of significance, respectively.

10 For the detailed econometric result of the ADF test, please refer to Annexure Table 1 to Annexure Table 4.

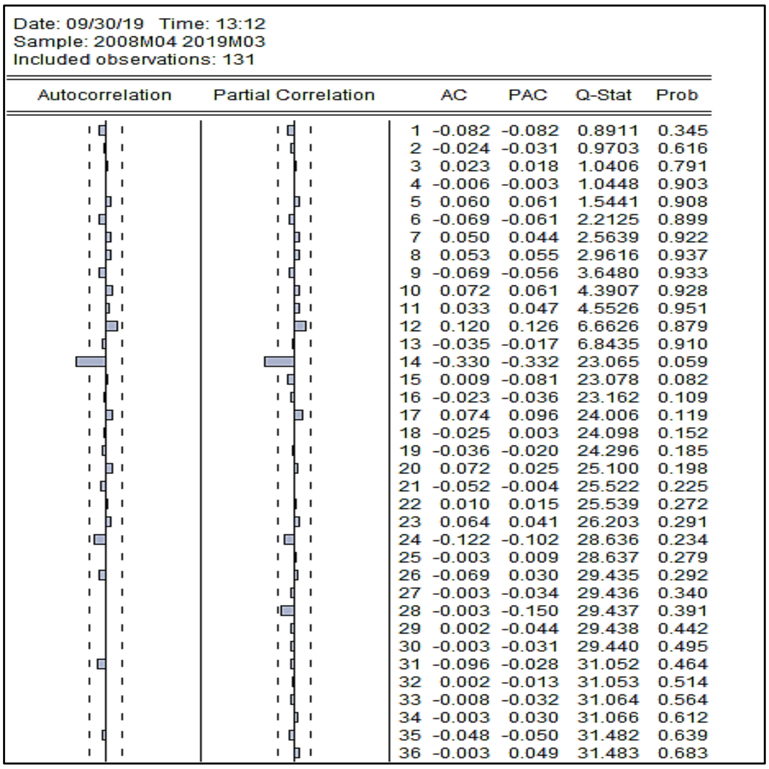
Therefore, the null hypothesis of unit root after the first difference is rejected, i.e. the series is I (1).



Date: 09/30/19 Time: 12:59
Sample: 2008M04 2019M03
Included observations: 132

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.964	0.964	125.51	0.000
		2	0.933	0.054	244.04	0.000
		3	0.904	0.010	356.09	0.000
		4	0.873	-0.033	461.45	0.000
		5	0.844	-0.001	560.57	0.000
		6	0.810	-0.069	652.73	0.000
		7	0.781	0.036	739.06	0.000
		8	0.749	-0.057	819.05	0.000
		9	0.714	-0.062	892.26	0.000
		10	0.682	0.029	959.80	0.000
		11	0.647	-0.073	1021.0	0.000
		12	0.609	-0.064	1075.7	0.000
		13	0.564	-0.138	1122.9	0.000
		14	0.519	-0.037	1163.3	0.000
		15	0.495	0.260	1200.3	0.000
		16	0.471	0.048	1234.1	0.000
		17	0.448	0.010	1264.9	0.000
		18	0.420	-0.096	1292.3	0.000
		19	0.391	-0.055	1316.3	0.000
		20	0.364	-0.012	1337.3	0.000
		21	0.333	-0.049	1354.9	0.000
		22	0.309	0.059	1370.2	0.000
		23	0.284	-0.019	1383.3	0.000
		24	0.251	-0.124	1393.6	0.000
		25	0.229	0.120	1402.3	0.000
		26	0.208	-0.014	1409.5	0.000
		27	0.191	-0.032	1415.6	0.000
		28	0.174	-0.012	1420.8	0.000
		29	0.156	0.082	1425.0	0.000
		30	0.139	-0.004	1428.3	0.000
		31	0.119	-0.016	1430.8	0.000
		32	0.104	0.007	1432.7	0.000
		33	0.089	-0.053	1434.1	0.000
		34	0.079	0.060	1435.2	0.000
		35	0.069	-0.024	1436.1	0.000
		36	0.057	0.023	1436.7	0.000

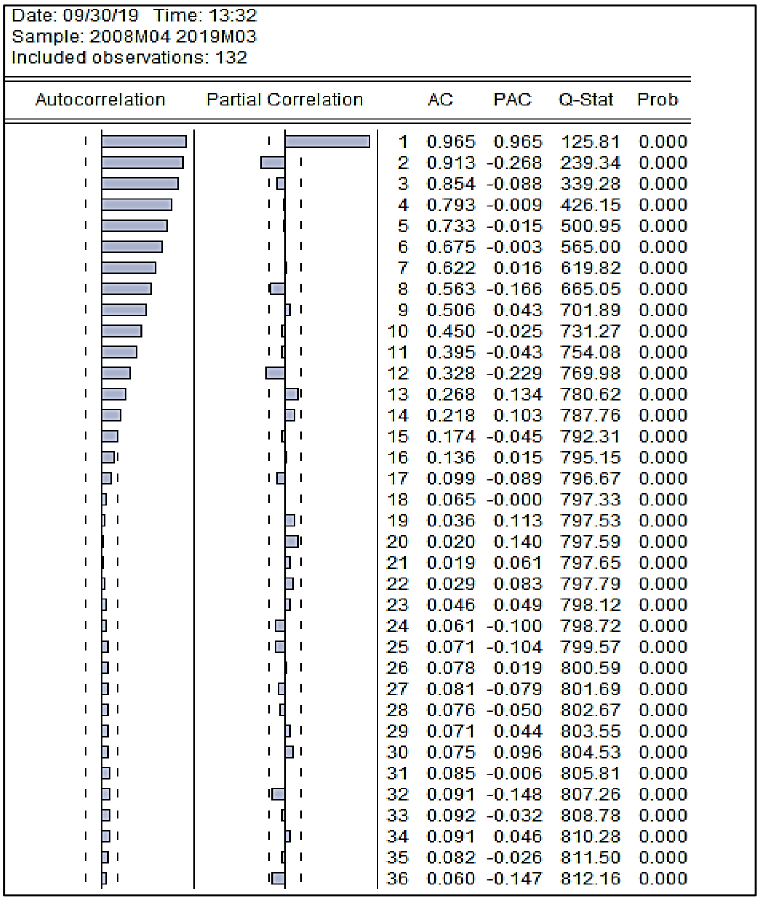
Figure 6.5 Non-stationary Eswatini correlogram (LYESWA at I (0))



Date: 09/30/19 Time: 13:12
Sample: 2008M04 2019M03
Included observations: 131

Lag	AC	PAC	Q-Stat	Prob
1	-0.082	-0.082	0.8911	0.345
2	-0.024	-0.031	0.9703	0.616
3	0.023	0.018	1.0406	0.791
4	-0.006	-0.003	1.0448	0.903
5	0.060	0.061	1.5441	0.908
6	-0.069	-0.061	2.2125	0.899
7	0.050	0.044	2.5639	0.922
8	0.053	0.055	2.9616	0.937
9	-0.069	-0.056	3.6480	0.933
10	0.072	0.061	4.3907	0.928
11	0.033	0.047	4.5526	0.951
12	0.120	0.126	6.6626	0.879
13	-0.035	-0.017	6.8435	0.910
14	-0.330	-0.332	23.065	0.059
15	0.009	-0.081	23.078	0.082
16	-0.023	-0.036	23.162	0.109
17	0.074	0.096	24.006	0.119
18	-0.025	0.003	24.098	0.152
19	-0.036	-0.020	24.296	0.185
20	0.072	0.025	25.100	0.198
21	-0.052	-0.004	25.522	0.225
22	0.010	0.015	25.539	0.272
23	0.064	0.041	26.203	0.291
24	-0.122	-0.102	28.636	0.234
25	-0.003	0.009	28.637	0.279
26	-0.069	0.030	29.435	0.292
27	-0.003	-0.034	29.436	0.340
28	-0.003	-0.150	29.437	0.391
29	0.002	-0.044	29.438	0.442
30	-0.003	-0.031	29.440	0.495
31	-0.096	-0.028	31.052	0.464
32	0.002	-0.013	31.053	0.514
33	-0.008	-0.032	31.064	0.564
34	-0.003	0.030	31.066	0.612
35	-0.048	-0.050	31.482	0.639
36	-0.003	0.049	31.483	0.683

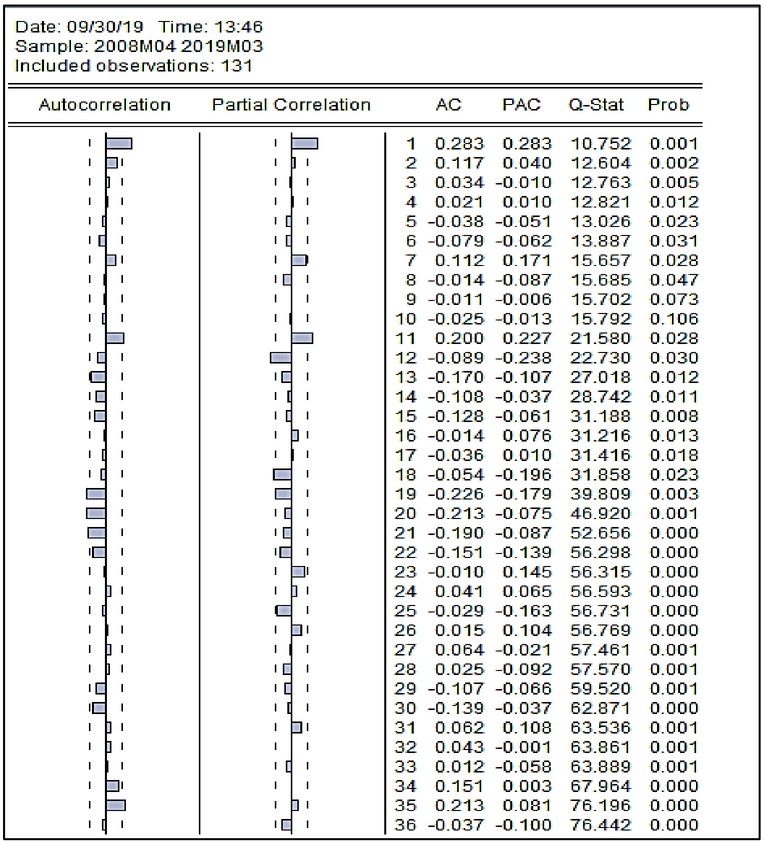
Figure 6.6 **Stationary Eswatini correlogram (DLYESWA at I (1))**



Date: 09/30/19 Time: 13:32
Sample: 2008M04 2019M03
Included observations: 132

Lag	AC	PAC	Q-Stat	Prob
1	0.965	0.965	125.81	0.000
2	0.913	-0.268	239.34	0.000
3	0.854	-0.088	339.28	0.000
4	0.793	-0.009	426.15	0.000
5	0.733	-0.015	500.95	0.000
6	0.675	-0.003	565.00	0.000
7	0.622	0.016	619.82	0.000
8	0.563	-0.166	665.05	0.000
9	0.506	0.043	701.89	0.000
10	0.450	-0.025	731.27	0.000
11	0.395	-0.043	754.08	0.000
12	0.328	-0.229	769.98	0.000
13	0.268	0.134	780.62	0.000
14	0.218	0.103	787.76	0.000
15	0.174	-0.045	792.31	0.000
16	0.136	0.015	795.15	0.000
17	0.099	-0.089	796.67	0.000
18	0.065	-0.000	797.33	0.000
19	0.036	0.113	797.53	0.000
20	0.020	0.140	797.59	0.000
21	0.019	0.061	797.65	0.000
22	0.029	0.083	797.79	0.000
23	0.046	0.049	798.12	0.000
24	0.061	-0.100	798.72	0.000
25	0.071	-0.104	799.57	0.000
26	0.078	0.019	800.59	0.000
27	0.081	-0.079	801.69	0.000
28	0.076	-0.050	802.67	0.000
29	0.071	0.044	803.55	0.000
30	0.075	0.096	804.53	0.000
31	0.085	-0.006	805.81	0.000
32	0.091	-0.148	807.26	0.000
33	0.092	-0.032	808.78	0.000
34	0.091	0.046	810.28	0.000
35	0.082	-0.026	811.50	0.000
36	0.060	-0.147	812.16	0.000

Figure 6.7 Non-stationary South African correlogram (LXSA at I (0))



Date: 09/30/19 Time: 13:46
Sample: 2008M04 2019M03
Included observations: 131

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.283	0.283	10.752	0.001
		2	0.117	0.040	12.604	0.002
		3	0.034	-0.010	12.763	0.005
		4	0.021	0.010	12.821	0.012
		5	-0.038	-0.051	13.026	0.023
		6	-0.079	-0.062	13.887	0.031
		7	0.112	0.171	15.657	0.028
		8	-0.014	-0.087	15.685	0.047
		9	-0.011	-0.006	15.702	0.073
		10	-0.025	-0.013	15.792	0.106
		11	0.200	0.227	21.580	0.028
		12	-0.089	-0.238	22.730	0.030
		13	-0.170	-0.107	27.018	0.012
		14	-0.108	-0.037	28.742	0.011
		15	-0.128	-0.061	31.188	0.008
		16	-0.014	0.076	31.216	0.013
		17	-0.036	0.010	31.416	0.018
		18	-0.054	-0.196	31.858	0.023
		19	-0.226	-0.179	39.809	0.003
		20	-0.213	-0.075	46.920	0.001
		21	-0.190	-0.087	52.656	0.000
		22	-0.151	-0.139	56.298	0.000
		23	-0.010	0.145	56.315	0.000
		24	0.041	0.065	56.593	0.000
		25	-0.029	-0.163	56.731	0.000
		26	0.015	0.104	56.769	0.000
		27	0.064	-0.021	57.461	0.001
		28	0.025	-0.092	57.570	0.001
		29	-0.107	-0.066	59.520	0.001
		30	-0.139	-0.037	62.871	0.000
		31	0.062	0.108	63.536	0.001
		32	0.043	-0.001	63.861	0.001
		33	0.012	-0.058	63.889	0.001
		34	0.151	0.003	67.964	0.000
		35	0.213	0.081	76.196	0.000
		36	-0.037	-0.100	76.442	0.000

Figure 6.8 Non-stationary South African correlogram (DLXSA at I (1))

6.3. COINTEGRATION TEST

After confirming the stationarity of the variables used and that it is in the same order of integration, a long-run relationship between South Africa and Eswatini was tested. The price series from both South Africa and Eswatini were found to be stationary of both orders of integration, which means that a long-run relationship between the two spatially separated markets can be tested. The cointegration test is used in the assessment of the long-run relationship between South African closing prices and Eswatini selling prices. A cointegration test explains the integration or relationship between two spatially separated markets through price transmission elasticities obtained when running a cointegration test. These elasticities provide an inference on how price movements and information move across the two markets studied in this research study. As indicated in the previous chapter, a two-step Engle and Granger test was employed in this study, based on the assumption of a unidirectional relationship to Eswatini from South Africa. The null hypothesis of the cointegration test is that there exists no cointegration between the Eswatini selling price and the South African closing price.

As discussed in above, the Engle and Granger cointegration test is a two-step process. First, an OLS regression is run, followed by testing the residual (U_t) for a unit root. The OLS regression was estimated with LYESWA (Eswatini selling price) as the dependent variable and LXSA (South African closing prices) as the independent variable. This was done to estimate the long-run relationship between the two markets. The results of the regression are shown in Table 6.2 below.

Table 6.2 OLS regression results[11]

Variable		
Coefficient	2.895	0.673
t-Statistic	8.149	14.55
Probability	0.000	0.000

The coefficient of LXSA (0.673) is significant at a 1% significance level. This means that South African maize prices affect Eswatini maize prices. The elasticity of transmission, at 0.673, tells us that a one per cent increase in South African prices of maize will result in a 0.673 per cent increase in Eswatini white maize prices. The LOOP is violated in this case since the elasticity is not equal to one. This could be attributed to the non-inclusion of transaction costs, current pricing policies and market structure, since the NMC can be regarded as monopolistic, resulting in drastic market deformities.

A unit root is tested on the residual (U_t) as the second step of the two-step Engle-Granger approach. A researcher would fail to reject the null of no cointegration, should the t-Statistic be greater than the critical values. As shown in Table 6.3, the null hypothesis of no cointegration at a 1% significance level can be rejected, since the t-Statistic (-2.681) is smaller

11 For the detailed econometric result of the Engle and Granger cointegration test, please refer to Annexure Table 5.

than the critical value (-2.583). It can be settled that the markets are cointegrated and possess a long-run relationship.

Table 6.3 Residual Unit Root test[12]

	Residual (U_t)
t-Statistic	-2.681
Critical Value	-2.583
Probability	0.008

6.4. ERROR CORRECTION MODEL (ECM)

Testing for a long-run relationship is not enough in assessing the relationship of prices, and further steps need to be taken to gain the full picture. An assessment of how deviations from the long-run dynamics can be fixed by short-run dynamics needs to be done thereafter. This can be done by employing the ECM. With the use of the ECM, a lag selection criterion is done as a first step. Lag order 2 was chosen for the series used in this study as indicated by the Akaike Information Criterion (AIC)[13].

The ECM was run to find the short-run dynamics of South African prices on Eswatini prices (Table 6.4). Should a shift/shock take place, the error correction term (ECT (-1)) depicts how variables adjust back to equilibrium in the long run. The error correction term in this study was found to be negative and significant at a 1% significance level, indicating that prices do correct back to the long-run equilibrium. The speed at which shocks are corrected per period, as indicated by the ECT, is 12.5%. This is quite a slow adjustment, implying inefficient correction for shocks. This supports the statement that the Eswatini maize market has inefficiencies that affect proper adjustments to shocks. Such inefficiencies may be accounted for by the current

12 For the detailed econometric result of the Residual Unit Root test, please refer to

Annexure Table 6.
13 See Annexure Table 7.

pricing policies that are in practice, a monopolistic maize selling market structure, and the occurrence of bottlenecks in information flow.

The slow movement of South African price shocks to Eswatini is evidenced by the significance of the lagged (D (LXSA (-1)) term at a 10% significance level. This means that the two markets are correlated, but that the correlation is weak in the short run. The short-run coefficient (0.127) of the previous period (D (LXSA (-1)) is significant, telling us that previous periods explain how changes in South African prices explain changes in Eswatini prices in the short run.

Table 6.4 ECM results (South Africa (LXSA) and Eswatini (LYESWA))[14]

Variable	C	D (LXSA (-1))	ECT (-1)
ECM coefficient	0.002	0.127	-0.125
Probability	0.730	0.092	0.000

6.5. SYMMETRY TEST

It is also very important to evaluate symmetry in price transmission of the two markets to understand the relationship between the prices as they fall or rise. This is done by doing the asymmetry test. For symmetry to exist, coefficients of negative and that of positive error terms must be statistically significant. The Wald F-statistic is used to test for symmetry under the null hypothesis of symmetry. Estimation of the error term coefficients is performed in the AECM and the error correction term is divided into two parts, i.e. negative (ECT_{t-1}^{-}) and positive (ECT_{t-1}^{+}). Asymmetry in price transmission may result from other factors such as transaction costs, inefficient market structure, policies governing the price, and information movements.

Symmetry was confirmed by the Wald F-statistic, as the test did not lead to the rejection of the null hypothesis of symmetry (Table 6.5). This tells us that symmetric correction exists between

14 For the detailed econometric result of the Residual Unit Root test, please refer to Annexure Table 8 and Annexure Table 9.

South African and Eswatini maize prices. The adjustment is not a strong one, judging by its closeness to the 10% significance level of rejecting the null hypothesis.

Table 6.5 Wald Test for South Africa and Eswatini[15]

Test Statistic	t-statistic	F-statistic
Value	-0.993	0.985
Probability	0.323	0.323

Eswatini selling prices only react to positive changes, as evidenced by Table 6.6. This means that there is no benefit for role-players in the maize market sector in Eswatini from lower South African prices. The coefficient of the positive ECT is negative and significant at the 1% significant level. The negative ECT, on the other hand, is insignificant. This gives more insight into the relationship between the two markets. About 16.7% of the total movement from the equilibrium level is fixed per term for positive changes or movements.

Table 6.6 AECM of Eswatini and South African Prices

Variable	**C**	**D (LXSA (-1))**	**$(ECT_{t-1})^{+}$**	**$(ECT_{t-1})^{-}$**
Coefficient	0.009	0.129	-0.167	-0.067
Probability	0.338	0.088	0.003	0.329

6.6. CONCLUSION

To carefully and correctly assess price transmission, we need to confirm that the data is stationary. That can be done by testing for a unit root. A unit root test was run and the data used in the study was found to be stationary after it was differenced once, meaning it was integrated

15 For the detailed econometric result of the Wald Test, please refer to

Annexure Table 10.

of order one I (1). After achieving stationarity of the data used, it was then proper to continue with the analysis of price transmission by testing for a long-run relationship between South African maize closing prices and Eswatini selling prices of maize. The Engle-Granger test for cointegration was employed to assess the long-run relationship and confirmed its existence between the two markets. After ascertaining that the result of the cointegration test was asymmetric, the Error Correction Model (ECM) was used to test for short-run dynamics between the two markets in question and it was revealed there is a correction to equilibrium at a slow rate. The Wald F test was then employed to test for symmetry in price correction under the null of symmetric correction, and it failed to reject the null of symmetry. It was revealed by the AECM that Eswatini selling prices only react to positive price changes from South Africa.

CHAPTER 7 CONCLUSION

7.1. INTRODUCTION

This chapter marks the conclusion of the study by summarising what was done in the study. Based on the results and outcomes of the study, a summary is drawn and recommendations are made.

7.2. CONCLUSION OF THE STUDY

The study assessed price transmission from South Africa to Eswatini to find out whether Eswatini can hedge the price of maize on the JSE CDM. It also looked at the value chain in Eswatini to analyse how it works, its structure and its effects on the price formation when it comes to white maize. To analyse the price transmission between South Africa and Eswatini, the literature on spatial price transmission was used to find the methods to be used and how to carefully use them for a proper and correct analysis. A comprehensive reading was done to map out the value chain in Eswatini. Price transmission was then tested with the consideration that Eswatini only imports its white maize from South Africa and does not export to South Africa. Although Eswatini is a very small market for South Africa, it is very important to study their relationship to lay down a base for further analysis as the two markets evolve in the future.

Throughout literature, price transmission is explained based on the LOOP, which hypothesises uniform prices across markets. The LOOP must hold under an efficient market or free trade, and the study's target was to find the extent to which the LOOP holds in the long and short runs. The closer conditions are to satisfying the LOOP, the greater the prospects are to hedge and the more efficient the value chain itself is.

The NMC is Eswatini's monopoly importer of white maize and has a level of control over its flow and over local maize market. It has input in pricing policies under the maize market, it is also responsible for the stability of the local maize market as a whole, and it is the one major actor in the value chain of white maize in the country. Together with the government, it makes the final decision on the pricing policies, which means that other factors like demand and supply and inflation have a lesser input into how prices are finalised. There is no known straightforward formula that is used in setting prices, especially the selling prices of white maize. Production within the country remains short and non-sustaining, despite the implementation of policies meant to protect local production agents.

The cointegration method for evaluating price transmission to Eswatini from South Africa was employed to find out if the prices in the two markets have a relationship in their movements. The Engle-Granger method, with the null hypothesis of no cointegration, was chosen for testing cointegration. Its null was rejected, implying that a relationship exists between the two markets' maize prices. In the long run, as discovered by the study, a 1% increase in South African prices will lead to a 0.67% increase in Eswatini prices in the case of white maize. This confirms co-movement in prices, but at a slow rate. Since a long-run relationship was confirmed, the study proceeded to look at the short-run dynamics and the ECT was negatively significant, with a 12.5% adjustment speed to equilibrium per term. This is a slow adjustment and may be the result of market conditions in Eswatini. The Wald F test was used thereafter to test for symmetry in price transmission. Asymmetry may arise due to various conditions, such as transaction costs and the active policies, in those respective markets being examined. The Wald F test has a null hypothesis of symmetry, and in the study it was not rejected since the probability was found to be 0.323. This insignificance is close to the 10% significance level, which resulted in the AECM being run to analyse short-run dynamics the ECT and it revealed that Eswatini only reacts to positive changes in South African prices. A highly significant and negative coefficient of the positive ECT was found, in contrast to the negative ECT that was insignificant and very small. A 16.7% movement away from equilibrium is corrected per term.

To conclude this study, it can be acknowledged that SAFEX can be used to hedge price risk by Eswatini. With that, the study confirms the hypothesis that hedging on SAFEX can be used as a tool to minimise price risk in the domestic maize market in Eswatini. This is possible as the study has confirmed a significant relationship between Eswatini and South African white maize prices. This again means that the favourable confirms its other hypothesis that there exists a significant relationship between maize prices as quoted on SAFEX and local maize prices in Eswatini. The study was also able to map along the value chain of maize, imported and local, through the current price discovery mechanism and market structure. It can be said that the value chain does not reflect a liberalised market environment and yields not much value addition to maize. In terms of price formation, the value chain actors as a whole have little impact due to the policies exercised by the NMC and the government. Nevertheless, the maize market and the relationship between South Africa and Eswatini could improve, should liberalisation in the Eswatini maize market be achieved through time.

7.3. RECOMMENDATIONS

Judging by the weak relationship and price transmission between South Africa and Eswatini as found by this study, a liberalised market would make the maize sector in Eswatini easier to prosper in. Allowing other entities, organisations and actors in the value chain to directly import maize from South Africa could help to improve the relationship and transmission of price and information between the two countries. This would in turn help to create fair and good prices for all the actors in the value chain. The NMC can remain as the main controller of the maize market, but only by ensuring maximum production of maize within the country through boosting production, with the provision of knowledge to farmers, especially by concentrating on small-scale and rural farmers of maize, as these farmers need to maximise yields. The NMC can also provide inputs and supervision to ensure they have the right inputs and guidance to maximise yields. This is a strategy used by one of the most profitable companies in the country, the Royal Swaziland Sugar Corporation (RSSC). They provide inputs and guide their out-grower sugarcane farmers through the growth of sugar and they achieve very good yields. This will ensure that food, especially maize, is affordable and that the country is food secure, thereby providing sufficiency and food security.

7.4. FUTURE RESEARCH RECOMMENDATIONS

The maize value chain was covered in the study and an idea of how it is functioning now was captured through analysing qualitative data, although much quantitative information is missing when it comes to the maize value chain in Eswatini. For future research, one can recommend that a full qualitative study on the maize value chain in Eswatini be undertaken, since that has not yet been done. Maize is a staple food in Eswatini and such a study could provide a valuable addition to the literature. This study can serve as a starting point and guideline for conducting a quantitative study of the value chain. Another recommendation is that a study should be done to quantify all the factors that affect price transmission and information transmission from South Africa and within Eswatini. Doing so will identify the major areas of investigation to concentrate on when transforming the maize industry to a more liberalised one.

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Annexures

Annexure A Univariate test graphs and correlograms

Annexure Table 1 Non-stationary Eswatini prices (LYESWA at I (0))

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.251485	0.7576
Test critical values:	1% level	-2.582734	
	5% level	-1.943285	
	10% level	-1.615099	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LYESWA)
Method: Least Squares
Date: 09/30/19 Time: 12:35
Sample (adjusted): 2008M05 2019M03
Included observations: 131 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LYESWA(-1)	0.000204	0.000813	0.251485	0.8018

R-squared	-0.000262	Mean dependent var	0.002045
Adjusted R-squared	-0.000262	S.D. dependent var	0.075046
S.E. of regression	0.075056	Akaike info criterion	-2.333568
Sum squared resid	0.732337	Schwarz criterion	-2.311620
Log likelihood	153.8487	Hannan-Quinn criter.	-2.324649
Durbin-Watson stat	2.162946		

Annexure Table 2 Stationary Eswatini prices (DLYESWA at I (1))

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.31488	0.0000
Test critical values:	1% level	-2.582872	
	5% level	-1.943304	
	10% level	-1.615087	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LYESWA,2)
Method: Least Squares
Date: 09/30/19 Time: 13:01
Sample (adjusted): 2008M06 2019M03
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LYESWA(-1))	-1.080726	0.087758	-12.31488	0.0000

R-squared	0.540363	Mean dependent var	0.000000
Adjusted R-squared	0.540363	S.D. dependent var	0.110800
S.E. of regression	0.075118	Akaike info criterion	-2.331839
Sum squared resid	0.727918	Schwarz criterion	-2.309781
Log likelihood	152.5696	Hannan-Quinn criter.	-2.322876
Durbin-Watson stat	2.004869		

Annexure Table 3 Non-stationary South African prices (LXSA at I (0))

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.304851	0.7725
Test critical values:	1% level	-2.582872	
	5% level	-1.943304	
	10% level	-1.615087	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LXSA)
Method: Least Squares
Date: 09/30/19 Time: 13:24
Sample (adjusted): 2008M06 2019M03
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LXSA(-1)	0.000295	0.000968	0.304851	0.7610
D(LXSA(-1))	0.284214	0.084837	3.350138	0.0011

R-squared	0.080213	Mean dependent var	0.003742
Adjusted R-squared	0.073027	S.D. dependent var	0.088017
S.E. of regression	0.084742	Akaike info criterion	-2.083139
Sum squared resid	0.919201	Schwarz criterion	-2.039023
Log likelihood	137.4040	Hannan-Quinn criter.	-2.065213
Durbin-Watson stat	1.985363		

Annexure Table 4 Stationary South African prices (DLXSA at I (1))

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.461586	0.0000
Test critical values:	1% level	-2.582872	
	5% level	-1.943304	
	10% level	-1.615087	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LXSA,2)
Method: Least Squares
Date: 09/30/19 Time: 13:33
Sample (adjusted): 2008M06 2019M03
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LXSA(-1))	-0.714754	0.084470	-8.461586	0.0000

R-squared	0.356891	Mean dependent var	0.000757
Adjusted R-squared	0.356891	S.D. dependent var	0.105299
S.E. of regression	0.084444	Akaike info criterion	-2.097798
Sum squared resid	0.919868	Schwarz criterion	-2.075740
Log likelihood	137.3569	Hannan-Quinn criter.	-2.088835
Durbin-Watson stat	1.985443		

Annexure B Econometric Results

Annexure Table 5 Engle-Granger test result for Eswatini (LYESWA) and South Africa (LXSA)

Dependent Variable: LYESWA
Method: Least Squares
Date: 09/30/19 Time: 14:33
Sample: 2008M04 2019M03
Included observations: 132

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.895077	0.355255	8.149297	0.0000
LXSA	0.672546	0.046213	14.55307	0.0000

R-squared	0.619651	Mean dependent var	8.059812
Adjusted R-squared	0.616726	S.D. dependent var	0.298782
S.E. of regression	0.184973	Akaike info criterion	-0.522174
Sum squared resid	4.447969	Schwarz criterion	-0.478495
Log likelihood	36.46349	Hannan-Quinn criter.	-0.504425
F-statistic	211.7918	Durbin-Watson stat	0.213440
Prob(F-statistic)	0.000000		

Annexure Table 6 Engle-Granger test result for Eswatini (LYESWA) and South Africa (LXSA)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.681376	0.0076
Test critical values:	1% level	-2.582734	
	5% level	-1.943285	
	10% level	-1.615099	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ECT)
Method: Least Squares
Date: 09/30/19 Time: 21:11
Sample (adjusted): 2008M05 2019M03
Included observations: 131 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT(-1)	-0.106520	0.039726	-2.681376	0.0083

R-squared	0.052400	Mean dependent var	-0.000247
Adjusted R-squared	0.052400	S.D. dependent var	0.085457
S.E. of regression	0.083188	Akaike info criterion	-2.127835
Sum squared resid	0.899621	Schwarz criterion	-2.105887
Log likelihood	140.3732	Hannan-Quinn criter.	-2.118916
Durbin-Watson stat	2.146300		

Annexure Table 7 ECM test results of LYESWA and LXSA

VAR Lag Order Selection Criteria
Endogenous variables: LYESWA LXSA
Exogenous variables: C
Date: 10/01/19 Time: 02:47
Sample: 2008M04 2019M03
Included observations: 124

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-12.33288	NA	0.004320	0.231175	0.276664	0.249654
1	280.2614	571.0308	4.11e-05	-4.423571	-4.287106*	-4.368136
2	287.5486	13.98664*	3.90e-05*	-4.476590*	-4.249148	-4.384198*
3	288.7482	2.263723	4.08e-05	-4.431422	-4.113003	-4.302073
4	290.9666	4.114841	4.20e-05	-4.402687	-3.993291	-4.236381
5	291.4816	0.938636	4.44e-05	-4.346477	-3.846105	-4.143214
6	292.0703	1.053897	4.70e-05	-4.291456	-3.700106	-4.051236
7	292.6395	1.000733	4.97e-05	-4.236121	-3.553795	-3.958944
8	297.0222	7.563681	4.94e-05	-4.242293	-3.468990	-3.928159

* 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

Annexure Table 8 ECM test results of LYESWA and LXSA

Dependent Variable: D(LYESWA)
Method: Least Squares
Date: 10/01/19 Time: 11:07
Sample (adjusted): 2008M06 2019M03
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002130	0.006162	0.345594	0.7302
D(LXSA(-1))	0.127462	0.075016	1.699128	0.0917
ECT(-1)	-0.124506	0.035995	-3.458973	0.0007

R-squared	0.145601	Mean dependent var	0.002061
Adjusted R-squared	0.132145	S.D. dependent var	0.075336
S.E. of regression	0.070182	Akaike info criterion	-2.452642
Sum squared resid	0.625541	Schwarz criterion	-2.386468
Log likelihood	162.4217	Hannan-Quinn criter.	-2.425753
F-statistic	10.82121	Durbin-Watson stat	2.219613
Prob(F-statistic)	0.000046		

Annexure Table 9 Symmetry test results for LYESWA and LXSA

Dependent Variable: D(LYESWA)
Method: Least Squares
Date: 10/02/19 Time: 11:04
Sample (adjusted): 2008M06 2019M03
Included observations: 130 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008705	0.009048	0.962075	0.3379
D(LXSA(-1))	0.129142	0.075040	1.720979	0.0877
ECT(-1)*(ECT>0)	-0.166591	0.055621	-2.995108	0.0033
ECT(-1)*(ECT<0)	-0.066910	0.068288	-0.979813	0.3291

R-squared	0.152229	Mean dependent var	0.002061
Adjusted R-squared	0.132044	S.D. dependent var	0.075336
S.E. of regression	0.070186	Akaike info criterion	-2.445045
Sum squared resid	0.620688	Schwarz criterion	-2.356814
Log likelihood	162.9280	Hannan-Quinn criter.	-2.409194
F-statistic	7.541662	Durbin-Watson stat	2.212457
Prob(F-statistic)	0.000111		

Annexure Table 10 Symmetry test results for LYESWA and LXSA

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	-0.992528	126	0.3228
F-statistic	0.985112	(1, 126)	0.3228
Chi-square	0.985112	1	0.3209

Null Hypothesis: C(3)=C(4)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3) - C(4)	-0.099681	0.100432

Restrictions are linear in coefficients.