The effects of drought on price transmission in the South African white maize market

By

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DECLARATION OF ORIGINALITY

I, Masego Nelly Moobi, hereby declare that this dissertation which I submit for the degree of MSc. Agric (Agricultural Economics) at the University of Pretoria is my own work and that it has not been previously submitted by me for a degree at this and for any institution of higher learning.

Signature ---

Date ---

DEDICATION

To my late mother, Dimakatso Moobi

and

My siblings, Didintle and Bopaki Moobi

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God has been my strength and my helper.

THE EFFECTS OF DROUGHT ON PRICE TRANSMISSION IN THE SOUTH AFRICAN WHITE MAIZE MARKET

By

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ABSTRACT

South Africa, on average, has received an annual rainfall of 600 mm since 1904. Over the years, the country has been characterised by frequent drought periods, with 2015 receiving the lowest rainfall since 1904, of 403mm. Drought has a negative impact on the physical agricultural production, with maize being the most affected by the recent 2015 drought. The South African white maize market is vulnerable to climate anomalies such as drought since 83% of white maize is produced under dry land conditions. The focus of the study is on the white maize market, given that it is a staple food for the majority of South African people and they spend a significantly large share of their income on purchasing maize meal.

The aim of this study is to understand the effects of drought on price transmission in the South African white maize market. This objective was achieved by using a Cointegration and Error Correction Model (ECM) that estimated price changes during a drought and recovery period. Drought, in this study, is defined as periods in which the annual average rainfall was below 600 mm, with rainfall above that being a recovery period. The study also used monthly white maize and maize meal prices for the period 2000–2017.

The findings of the study highlight that shocks to the system during both drought and recovery are corrected at a slow pace. However farm-price changes trigger a faster response during drought than in a recovery period. There is no indication of asymmetry in the white maize market, more particularly during a drought period. However, error correction terms for producer price decreases during a recovery period were not significantly different from zero. This implies that any cost savings during a recovery period are not passed on to the

consumers. Moreover, poor consumers pay a larger share of their income for maize meal during a recovery period, as opposed to a drought period, leaving them worse off.

This study provides insight on the pricing behaviour of role players, given rainfall variability. The study also highlights how these pricing mechanisms affect consumers, especially low-income earners, who constitute the majority of the South African population. This study recommends that in any fiscal planning, especially for social welfare grant adjustments, consideration should be given to rainfall pattern projections before decisions are made.

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LIST OF ACRONYMS

ACB	African Centre of Biodiversity
ADF	Augmented Dickey Fuller
Agri SA	Agric South Africa
BFAP	Bureau for Food and Agricultural Policy
CPI	Consumer Price Index
DAFF	Department of Agriculture Forestry and Fisheries
ECA	Economic Commission for Africa
ECM	Error Correction Model
ECT	Error Correction Term
ECTD	Error Correction Term (during a) Drought period
ECTR	Error Correction Term (during a) Recovery period
ENSO	El Nino Southern Oscillation
FPL	Food Poverty Line
FST	Fishmeal Soyabean meal Ratio
GDP	Gross Domestic Product
GMO	Genetically Modifies Organisms
LBPL	Lower Bound Poverty Line
LSM	Living Standard Measure
MM	Millimetres
OLS	Ordinary Least Squares
PP	Phillips Perron
PPPM	Per Person Per Month
SAFEX	South African Futures Exchange
SAGIS	South African Grain Information Service
StatsSA	Statistics South Africa
UBPL	Upper Bound Poverty Line
Weather SA	Weather South Africa

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Drought is severe and frequent in many African countries due to extreme variabilities of rainfall (Benson & Clay, 1998). Since 1900, there have been approximately 642 drought events reported across the world (Masih, Maskey, Mussa, & Trambauer, 2014). Africa accounted for the largest share (45%) of these incidences, and according to Stringer, Dyer, Reed, Doughill, Twyman and Mkwambisi (2009), it is expected that drought will become more frequent across the continent over the years to come. The Economic Commission for Africa (ECA) (2007) defines drought as an extended period wherein rainfall is lower, relative to the statistical multi-year average of a region. The South African long-term annual average rainfall for periods between 1904 and 2017 was approximately 600 mm (Weather SA, 2018). Thus, drought is a recurring phenomenon in South Africa, with a record of approximately 20 years where rainfall was below a long-term annual average since 1970. According to Weather SA (2018), in 2015, the South African rainfall was at its lowest since 1904, with an annual average of 403mm. This led to official declaration of disaster in all but the Eastern and Western Cape provinces (AgriSA, 2016).

Climate anomalies such as drought have an impact on commodity production and price changes (Ubilava, 2014). The recent drought in South Africa has had an initial negative physical impact on primary agricultural production (AgriSA, 2016) and led to food price hikes. A decline in rainfall led to approximately 30% of the total agricultural hectares being damaged in the summer of 2015 (Willemse, Strydom, & Venter, 2015), particularly in white maize production areas (African Centre of Biodiversity, 2016). Between 2014 and 2015, there was a decline in annual average rainfall, from 581 mm to 403 mm (30% decline), which probably caused the 28% decline in South African maize production. Basic food staples were most affected by drought (Bureau of Food and Agricultural Policy, 2016a), although maize was more severely affected by the recent drought than other agricultural products were (AgriSA, 2016). The South African white maize market is vulnerable to drought effects, given that 83% of the country’s white maize is produced under dry land farming (AgriSA, 2016).

Maize is an important crop in South Africa as it is the second most-produced crop (tons) after sugar cane (DAFF, 2016). It is a source of carbohydrates and forms an important staple for South Africans. Maize meal ranks second (after poultry) on the list of food items that poor consumers spend their income on (BFAP, 2016b). This study adopts three poverty lines used by StatsSA (2017) as the definition for poor consumers. The three poverty lines categorise South Africans according to Food Poverty Line (FPL), Lower Bound Poverty Line (LBPL) and Upper Bound Poverty Line (UBPL) for those who earn an average of R441, R647 and R991 per month, using 2015 prices respectively. Therefore, the poor comprise the majority of consumers, as they constituted approximately 55% of the total adult population in South Africa in 2015 (StatsSA, 2017). A drop in agricultural production has a negative impact on household livelihoods and national food security. This is because poor households do not have adequate resources to deal with food shortages (ECA, 2007). Moreover, food is price inelastic; even when food prices increase, consumers will continue to purchase the same quantity of food items (Mohr & Fourie, 2008). Hence, the poor are characterised as spending a large share of their income on food (Greyling, 2012) (van der Heijden & Tsedu, 2008)

Similarly to food scarcity, drought may have an impact on how food price changes are transmitted along a food marketing chain (Çamoğlu, Serra, & Gil, 2015), leading to asymmetric price responses. Ubilava (2014) evaluated the effects of an El Nino Southern Oscillation (ENSO) on the fishmeal–soya bean meal price ratio (FSR) and found that El Nino shocks have asymmetric transmission impacts along that marketing chain. Asymmetric price transmission takes place when the producer price decreases, yet this decline is not passed on to the consumers fully, or it reaches them at a slow pace (Rezitis & Pachis, 2016). Furthermore, von Cramon-Taubadel (1998) defines asymmetric price transmission as a reaction of price change at one level of the value chain, depending whether the initial change is either positive or negative. The welfares of both consumers and farmers are affected by asymmetric price transmission passed from one point of the value chain to another.

Price is an important component of market economy, which coordinates the decision-making of producers and consumers in the optimal allocation of scarce resources under perfect competition (Brummer, von Camon-Taubadel, & Zorga, 2009). Vertical price transmission provides an understanding on how prices are transmitted from one point of a marketing chain to another i.e. from farm; wholesale to retail, and the speed at which these prices are transmitted (FAPRI, 2013) (Mkhabela & Nyhodo, 2011). Studies on vertical price transmission have gained much attention among researchers. This is as a result of social and political concerns regarding how prices are transmitted along a marketing chain (Serra & Goodwin, 2003), particularly price increases (Mkhabela & Nyhodo, 2011). Also, the fundamental reason for analysing agricultural markets is to ascertain the extent to which the several players along the value chain respond to changes in the commodity or farm prices (Rapsomanikis, Hallam, & Conforti, 2003). Therefore, if price transmission is asymmetric it implies that inaccurate information may be conveyed to producer and consumers and thus a misallocation of resources in an economy (FAPRI, 2013). It is against this background that this study provides knowledge for policy-makers on the effects of drought on price formation in the white maize market.

1.2 PROBLEM STATEMENT

South African rainfall, since 2000, has been below the long-term annual average of 600 mm in 2002, 2003, 2004, 2005, 2007, 2008, 2013, 2014 and 2015 (Weather SA, 2018). Since 2000, drought has become more recurrent, given that in the 15 years before then (1984–1999), South Africa had only recorded six years where rainfall was below the annual average. This indicates that low-rainfall patterns are expected to become more frequent in the future (ECA, 2007). The drop in rainfall levels has had a negative impact on agricultural production, particularly white maize production. Maize production was, on average, 8% lower during a drought period than a recovery period between 2000 and 2015 (DAFF, 2016). Thus, it is expected that periods of low rainfall disrupt market conditions (Ubilava, 2014).

Data from DAFF (2016) shows that commodity and retail price movements respond differently during drought and recovery periods. Commodity prices, on average, show an upward price trend during a drought period. This is expected, as drought leads to a decline in production and therefore an increase in prices. During a recovery period, increases in the national annual average rainfall lead to increases in commodity production, and subsequently, prices decline. Therefore, commodity prices respond as expected according to the prevailing market forces (Mohr & Fourie, 2008). Data from DAFF (2016) also highlight the point that retail prices show periods where the response is contrary to market forces in a competitive market. Recovery periods are characterised by increases in retail prices, rather than during drought periods, thus suggesting the presence of asymmetric price transmission that is influenced by drought episodes.

Ubilava (2014) found that food price fluctuations caused by repeated drought incidences are not fully transmitted to consumers. This was more particular for cost savings from the producer point of the value chain, while price increases are transmitted faster. Asymmetric price responses result in welfare losses due to basic food items remaining at higher price levels than necessary, i.e. prices remain higher during a recovery period, when they would be expected to decline. This implies that they will spend a large share of their income on food, while sacrificing non-food items, which makes them worse off in comparison to a drought period. High prices of basic food items affect poor consumers, who spend approximately 33% of their income on food, as compared to 10% spent by the non-poor consumers (StatsSA, 2017), (BFAP, 2016b), (ACB, 2016). Poor consumers do not have adequate resources to deal with price increases (ECA, 2007). This study will focus on the maize and maize meal prices as the expenditure (32%) of poor consumers, who account for 55% of the population and whose food choices are dominated by staple foods (BFAP, 2016a).

1.3 RESEARCH OBJECTIVES

The main aim of this study was to assess the effects of drought on price transmission along the South African white maize marketing chain. This was achieved through engaging with the following three specific-objectives:

1. to analyse price movements in the white maize and maize meal prices during recovery and drought periods
2. to examine price transmission along the white maize marketing chain for recovery and drought periods in the long and short runs.
3. to evaluate the impact of drought in the white maize market on poor consumer's expenditure share.

1.4 RESEARCH METHODOLOGY AND HYPOTHESIS

The early work on price transmission by Farrell (1952) and Tweeten and Quance (1969) used cross-market price correlation or simple regressions to test the degree of market integration. However, there were growing realisation that price series are often non-stationary, i.e. the variable mean and variance change over time, resulting in misleading statistical outcomes; hence, the popular use of cointegration methods (Balacome, Bailey, & Brooks, 2007).

This study employed cointegration and error correction techniques to capture price behaviour in the white maize market, given the presence of drought periods. Definitions of drought are often specific to a location, with a threshold being used to differentiate drought from non-drought periods (Wilhite & Glantz, 1985). This study considers periods where the national annual average rainfall of below 600 mm as drought periods, and those above 600 mm as recovery periods.

Monthly data of maize and maize meal from January 2000 until December 2017 were analysed to address the objectives of this study. Drought dummy variables were used to differentiate drought from recovery periods. The study is guided by the hypotheses and methodologies employed that are outlined in Table 1.1 below.

Table 1.1: Research question, hypothesis and methodology presentation

Research questions	Hypotheses	Methodology
Given that drought affects market conditions, what is the price change of white maize and maize meal prices during a drought and recovery period?	Both white maize and white maize meal prices changes are higher during a drought period than they are during a recovery period.	Descriptive statistics was used to address the respective research question.
Given that the direction of price flow is determined, what is the nature of price transmission in the white maize market during drought and recovery periods? i.e. are prices passed on from one point of the market chain to another at the same speed during a drought and a recovery period?	Transmission (speed) of increasing prices from one point of the white maize market to the next is the same as that of decreasing prices during drought and recovery periods.	The Engel and Granger Cointegration and Error Correction Model (1987) were used to address the research question. This ECM illustrates short-run dynamics that restore equilibrium relationships which are represented by cointegrating vectors given an asymmetric shock.
What is the change in expenditure share of the poor on maize meal during drought and recovery periods, i.e. value of consumer loss due to rainfall variability?	Rainfall variability results in a higher consumer welfare loss during a drought period as opposed to a recovery period.	Descriptive statistics were used to address the respective research question.

1.5 JUSTIFICATION OF THIS STUDY

This study is, to the author's knowledge, the first to assess the effect of drought on price transmission along the South African maize marketing chain and its resultant effect on the incomes of poor consumers.

The study contributes to the understanding of price changes between drought and recovery periods in the white maize market. This is important for policy formulation, particularly policy related to inflation targeting and consumer welfare. The study also contributes to the understanding of how rainfall patterns affect price formation in the white maize market. This will provide information to key economic agents in formulating response strategies to drought episodes. This will enable them to adjust to forecasted supply shortages and adjust their practices accordingly to mitigate the effects of drought shocks (Ubilava, 2014).

Lastly, the study contributes to the body of literature on consumer welfare. The findings of the study provide an understanding of the effects of drought on consumer spending patterns. The latter contribution is of particular importance to policy makers in considering the impact of price increases on poor consumers.

1.6 STUDY LIMITATIONS

Price transmission studies consider prices at different points of the value chain, namely the farm, wholesaler and the retailer points (Goodwin & Holt, 1999). This is done to identify aspects that are responsible for increased margins between the farm and retail points. However, due to the nature of food industries, it is difficult to identify the points in the value chain that are responsible for the increased price margin between the farm and retail points (Cutts & Kirsten, 2006). Thus, due to the lack of wholesale price information, only commodity and retail prices will be considered in the present study. Cutts and Kirsten (2006) used a similar approach and explained that it provides a good estimation of the activities of market participants at different levels.

1.7 OUTLINE OF THE STUDY

This section provides the reader with background knowledge of the study and the objectives that it sets out to achieve. This dissertation analyses the effects of price transmission resulting from drought in the South African white maize market for the period between 2000 and 2017. The study is divided into chapters as follows:

Chapter 2 gives an overview of and background to drought episodes, production, and price trends of the analysed agro-food industry. It also provides a general overview of food price trends, along with consumption behaviour patterns of South Africans. The aim of this chapter is to give the results of this study context and to gain an idea of how the results may impact on the industry.

Chapter 3 provides literature on the theory of price transmission. It also highlights the theoretical framework, explaining welfare effects of the presence of asymmetric price transmission in the white maize market.

A description of data sources and methods used to address the objectives of the study are discussed in **Chapter 4**.

Chapter 5 presents the results, based on the preceding chapter. The results are divided into descriptive and inferential analyses.

Chapter 6 concludes the study and provides recommendations for further related work.

CHAPTER 2

SOUTH AFRICAN DROUGHT PERIODS, WHITE MAIZE MARKET, AND CONSUMER PROFILE: AN OVERVIEW

2.1 INTRODUCTION

In gaining an understanding of the nature of price transmission in a market, it is important to study the price behaviour relating to a product in relation to drought at different levels of the value chain, i.e. from farm to retail. At farm level, drought has a negative implication for agricultural yield, which is then followed by a response in price changes. However, the socio-economic impacts of drought are wide. The first section of this chapter provides an overview of drought, the effects of drought on an economy, and its historical frequency and severity in South Africa.

This is followed by a descriptive overview of maize production and its price trends. This gives the reader an understanding of the impacts of drought on South Africa maize production. This is then followed by an outline of the historical inflation trends that capture the responses of food prices to drought. The last section gives a description of poor consumers in South Africa and their food consumption patterns. The essence of the literature survey is to provide the reader with an appreciation of the link between historical drought episodes and price changes. It also provides an understanding of maize meal consumption patterns, which form the basis for the study's theoretical framework in Chapter 3.

2.2 DROUGHT

Variability in rainfall and its timing are some of the characteristics of regional climate change, and these have been increasing over the last 50 years. Hence, drought has become a topic of interest to researchers and policy makers, particularly its history, frequency and impact on different economies (Wilhite & Glantz, 1985). The primary impact of drought is seen through the reduction of agricultural production, with vast secondary effects given the connectedness of the agricultural sector with other sectors of an economy. Drought takes place for a particular period, although its effects on a society linger for longer. Thus, drought cannot only be viewed from a meteorological perspective, societal effects are also very important.

2.2.1 Definition of drought

Drought occurs at varying frequencies across different regions with differing economic systems. Therefore, according to Wilhite and Glantz (1985), definitions of drought reflect regional differences. Common definitions of drought originate from the premise that rainfall shortage leads to water shortages for some purposes, such as agricultural production or for some group of people such as farmers (Wilhite & Glantz, 1985) (ECA, 2007). Drought is a concept that cuts across several disciplines and thus can be defined to capture areas of interest such as meteorology; agriculture and economics.

Meteorological definitions of drought are specific to a particular place, with the use of a threshold differentiating drought periods from non-drought periods. ECA (2007) used annual rainfalls to define drought as a condition wherein the annual rainfall of that region for an observed period, such as a season, a year or several years, is below the long-term annual average. Wilhite and Glantz (1985) cite some of the meteorological drought definitions adopted by different regions:

- United Stated of America –Rainfall of below 2.5 mm in 48 hours;
- Britain – 15 days wherein rainfall in each day was below 0.2 mm;
- Libya – Annual average rainfall of below 180 mm
- Bali – A period 6 days without rainfall.

According to Weather SA (2018), South Africa receives an annual average rainfall of 600 mm per annum; therefore, any level below the annual average can be defined as drought. Economic drought is associated with low rainfall outside the normal range that affects the supply and demand of an economic good (Wilhite & Glantz, 1985). It usually covers the effects of drought on the performance of an economy, as shown in Figure 2.1 below. Benson and Clay (1998) defined economic drought as “a meteorological anomaly or extreme events of intensity, duration (or both) outside the normal range of events that enterprises and public regulatory bodies have normally taken into account in their economic decisions and that, therefore, results in unanticipated (usually negative) impacts on production and the economy in general”.

2.2.2 Impact of drought

Drought takes place for a particular period, leaving some immediate impacts, while others will be transmitted long after the drought period. The impacts of drought largely depend upon a society's vulnerability to drought (Wilhite & Glantz, 1985). Thus, economies in developing countries whose agricultural sector contributes a large share to the Gross Domestic Product (GDP) will be more affected by drought than economies in developed economies, which have a relatively smaller agricultural GDP share. Drought periods are usually followed by negative physical impacts on agricultural production (Benson & Clay, 1998), and these immediate impacts are translated to other sections of an agro-system or an economy as shown in Figure 2.1.

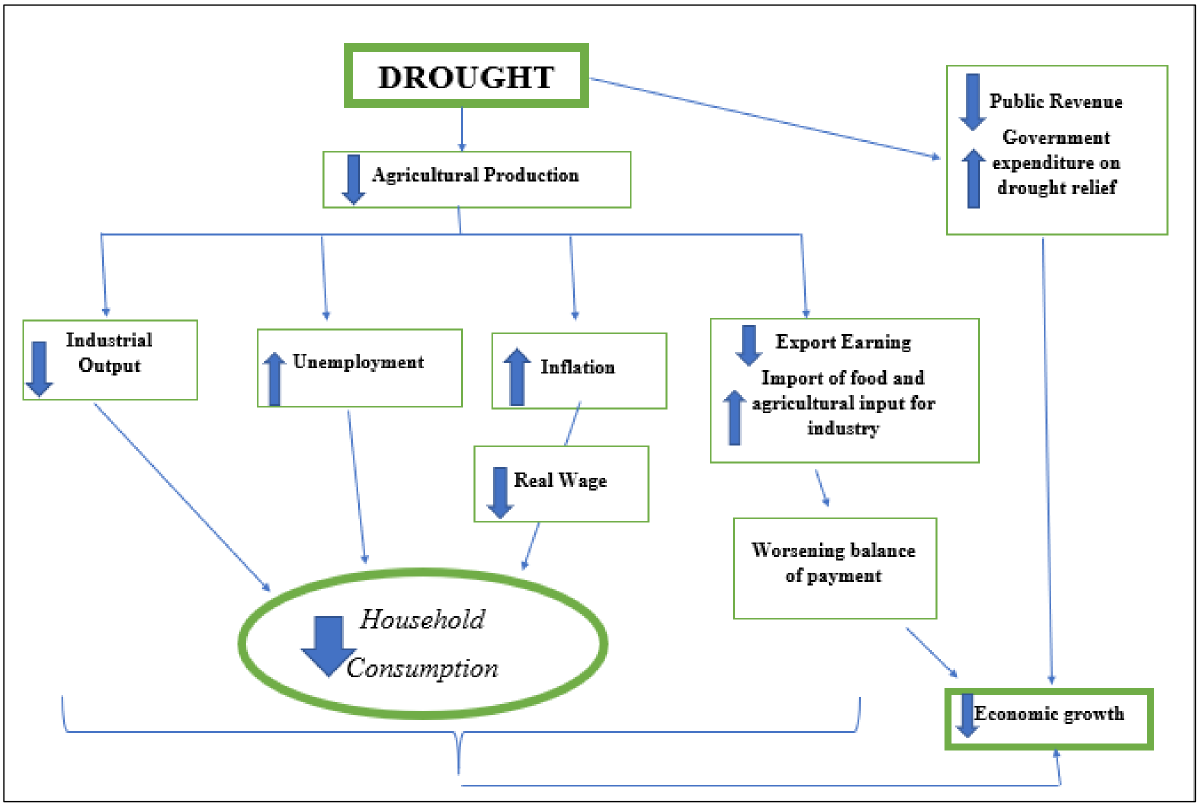

Figure 2.1: Transmission of drought shock

Source: Adapted from AgriSA (2016)

As highlighted in Figure 2.1, drought periods are associated with low agricultural production. A decline in agricultural productions implies that a country needs to rely on imports to meet its domestic demand, while it loses on export earnings. In addition, a decline in agricultural production leads to higher food prices and subsequently a decline in real income. High food inflation rates impact on poor consumers more than the affluent consumers, and this worsens income inequality. Moreover, poor consumers do not have adequate resources to deal with their food shortages, thus leading to food insecurity. Drought also has a negative impact on agricultural employment, exacerbating poverty. All these factors shrink the agricultural sector's contribution to the GDP, along with other industries which depend on agriculture for raw materials and this undermines economic development (see Figure 2.1 above). The impacts of drought show that the interactions between drought shocks and the economy are complex, rather than direct and straightforward (Benson & Clay, 1998).

2.2.3 Drought in South Africa

Drought is one of the prevailing climate change challenges facing sustainable development and economic growth across the African continent. According to the ECA (2007), the African continent has experienced a high frequency and severity of droughts. Since 1900, Africa has recorded 291 drought events, which account for 45% of globally reported drought events (Masih et al, 2014). Given the advent of climate change, the continent is expected to become hotter and drier, with droughts also expected to become more frequent across Southern Africa (Stringer et al., 2009).

South Africa is a semi-arid to arid country with constrained fresh water resources (Water Research Commission, 2015). Limits in water resources are further affected by climate variability and change. When a country experiences highly variable climate and extreme weather changes, drought then becomes a recurrent characteristic feature. South Africa is prone to recurrent droughts due to its long-term annual rainfall, averaging at approximately 600 mm (Weather SA, 2018). This is an average value for the periods between 1904 and 2017. Thus in the South African context, drought is defined as any period where the annual average rainfall is below 600 mm. South Africa also goes through periods where there is more rainfall above the normal , and periods where it receives below-normal average rainfall. These drought events are known as the La Nina and El Nino, respectively.

Historical South African annual average rainfalls for periods between 1970 and 2017 are highlighted in Figure 2.2 below. During this time, South Africa had a record of 20 years where rainfall was below the normal average since 1970. Figure 2.2 also shows that over the years, drought has become more frequent. Between 1994 and 2017 there were 2 occurrences where the annual rainfall has been below 600 mm for four consecutive years i.e., 2002-2005 and 2012-2015. While between 1970 and 1993, South Africa recorded only 1 period of 3 consecutive drought years.

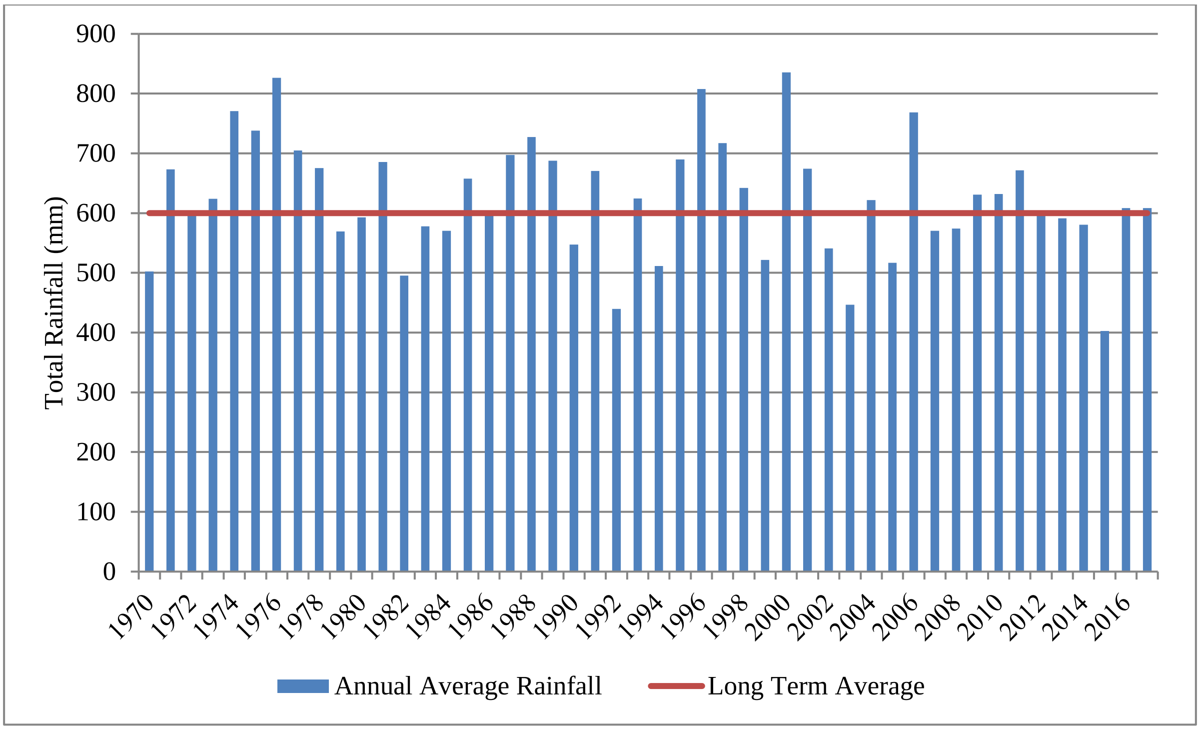

Figure 2.2: South African long-term annual average rainfall

Source: Weather SA (2018)

Between 1991 and 1992, South Africa experienced an El Nino induced drought, which was regarded as the worst in the 20th century. Weather SA (2018) has stated that in 2015, South Africa received its lowest annual average rainfall of 403mm since 1904, making it worse than the 1991 and 1992 drought periods. Its impact started in the Western Cape and KwaZulu-Natal regions in winter, and then escalated in November and December towards the inland provinces (BFAP, 2016a). The impact of this drought was felt through agriculture and through the reduction in the water supply and water quality. The agricultural sector is not only affected by drought, but it also affects other sectors of the economy through its agricultural linkages (Pretorius & Smal, 2012). Maize production was the most affected by the 2015 drought given that majority of white maize production is under dry land.

2.3 MAIZE PRODUCTION TREND

Maize is an important crop in South Africa as it is the second most-produced crop after sugar cane (DAFF., 2016). It forms a staple food for the majority of the population. Figure 2.3 below illustrates white maize production deliveries for the period between 2000 and 2017. Production deliveries have been fluctuating, yet have maintained an increasing trend over the years, and this may be largely due to several events such as rapid food and producer price increases, favourable weather conditions, the adoption of GMO seeds and improved production practices (Sihlobo, 2016). Between 2000 and 2001, white maize production deliveries declined by 31%, after which as producer prices increased, white maize deliveries increased by 19% between 2002 and 2003. During the 2007 economic meltdown, white maize deliveries declined by 33%, followed by an upswing of 73% in the following year.

The rapid increase of maize deliveries in 2008 was attributed to high volumes that were released from the reserves. According to DAFF (2016), this was also influenced by increases in the producer price which encouraged farmers to increase their maize production.

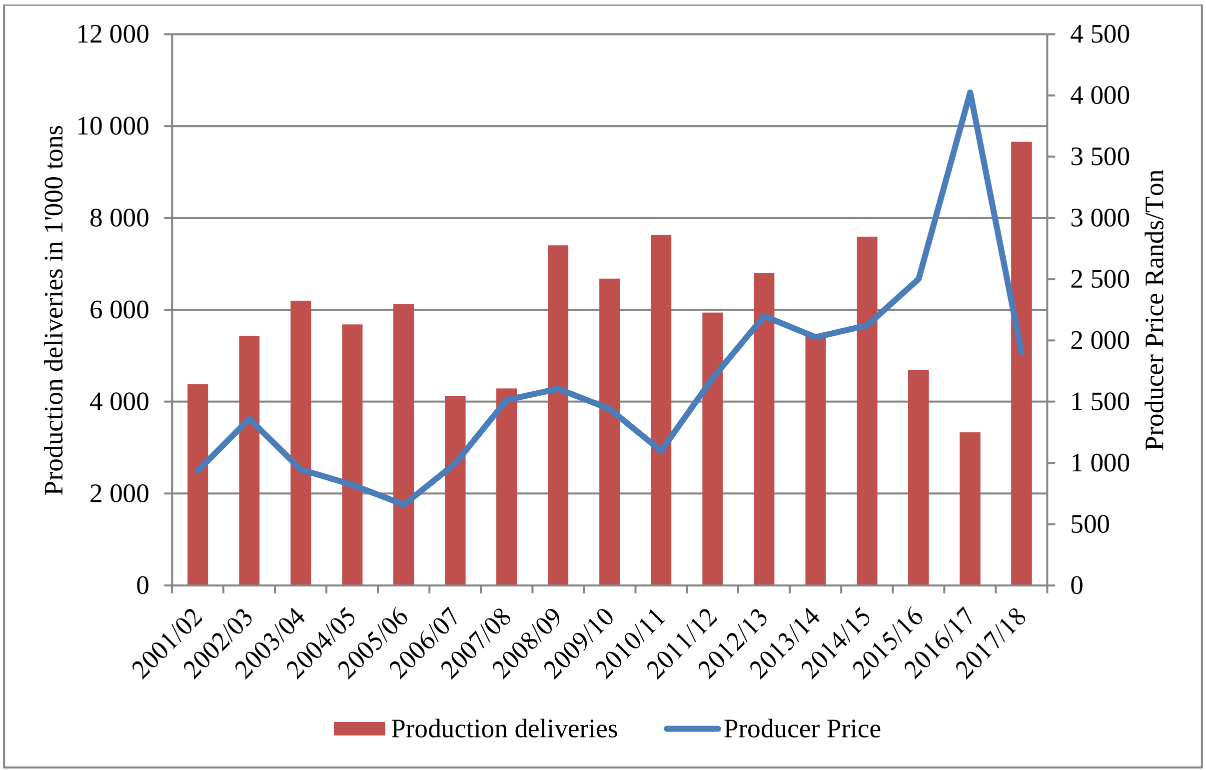

Figure 2.3: White maize production deliveries

Source: SAGIS (2018)

The increase in maize deliveries between 2009 and 2010 was the result of improved yield and higher rainfall projections (DAFF, 2016). Of importance to this study is the period between 2013 and 2015, when South Africa was experiencing drought. During that period, white maize deliveries declined year on year at an average rate of 6%. In 2015, South Africa experienced the highest drop of 38% in maize deliveries since 2000. This shows the extent to which drought has affected maize production, in particular, in the country. Furthermore, BFAP (2016a) stated that in 2015 there was a 30% decline in the area planted to maize, which led to a decline in white maize production, also pointing to the severity of drought as opposed to economic factors.

Dryland agricultural production is of particular importance, thus rendering South Africa vulnerable to drought. Approximately 83% of domestic maize is produced under dry land conditions (AgriSA, 2016). Thus, drought threatens the maize production needed to meet the staple consumption demands in both the domestic market and in neighbouring importing countries.

Maize is predominantly produced in the Free State, Mpumalanga and North West provinces, with eight-year averages (2008–2015) of 40%, 22% and 20%, respectively (see Figure 2.4 below). Maize is grown in these areas due to their similar climatic conditions which are suitable for maize production.

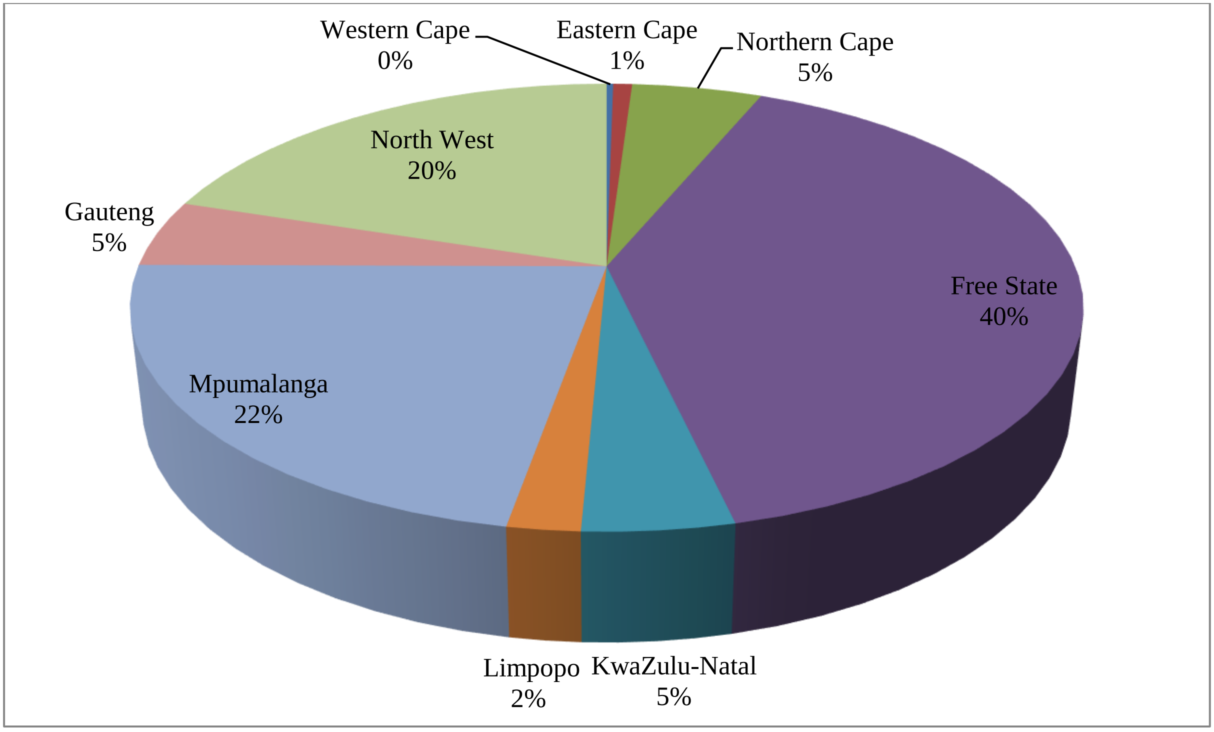

Figure 2.4: South African average production volume share, 2008–2016

Source: DAFF (2016)

Maize is also produced in the Western Cape, which experiences winter rainfall, as well as in the Karoo and Eastern Cape, although there is no commercial production in the latter regions. White maize is produced in the western region of the country.

White maize kernel in South Africa is processed by the wet and dry milling industries. The latter industry processes white maize kernel into samp, maize grits and maize rice, sifted, un-sifted, coarse, super and special maize meal (DAFF, 2016). Figure 2.5 below illustrates the historical trend of processed white maize for the domestic market. The amount of processed white maize was at 4.8 million tons in 2015, as compared with 2.8 million in 2000. It was processed into animal feed and food items for human consumption.

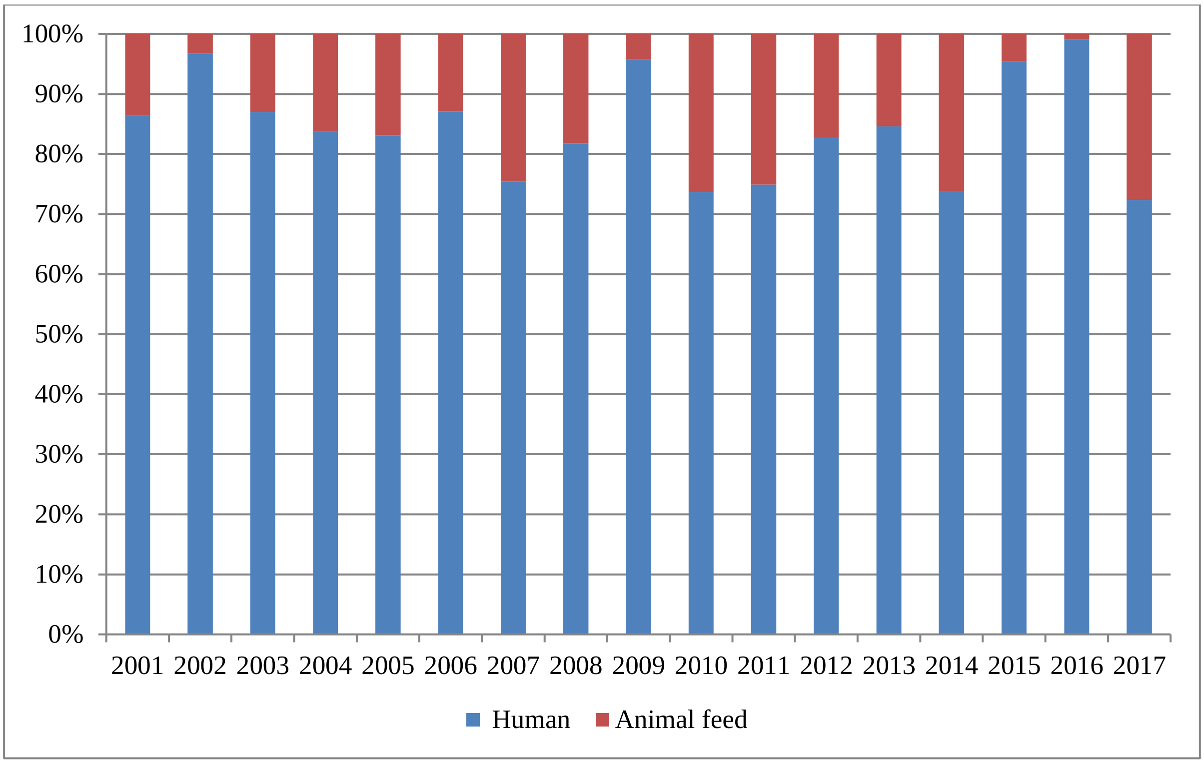

Figure 2.5: South African white maize processed for local market

Source: SAGIS (2018)

From Figure 2.5, it is evident that white maize in South Africa is predominantly processed into food items, with an average share of 85%. However, between 2007 and 2015, white maize processed for animal feed accounted for 19% as compared with 12% between 2000 and 2006. This may suggest an increasing demand for feed to satisfy a corresponding rise in demand for meat and the diversification of consumer diet for starches. In the short term, the demand for maize products for consumption is high, as consumers switch to more affordable starch foods. However, in the medium term, the demand for maize food stagnates, as consumers substitute these for alternative starches such as bread and rice (BFAP, 2016c). Therefore the demand for white maize for feed may lead to increases in maize meal prices in the long run.

2.4 FOOD INFLATION

Food inflation occurs when the aggregate quantity of food demanded exceeds what is supplied at a certain price and time (Ularo, 2010). Since the 2007/08 world food price crises, food inflation has been a growing concern for the international development agenda. The process began mid-2006 when food price hikes started in the international markets (Mendoza & Machado, 2009). Prices of essential products have increased considerably and this has resulted in worldwide negative effects, such as rapid inflation rate and reduction in real consumption, particularly for the poor. The global food system is under pressure in dealing with multiple and conflicting factors. Increases in the demand for productive resources, rapid increases in population growth, climate change, degradation and exploitation of productive resources are some of the factors that lead to increases of food prices (Hampton & Weinberg, 2014)

2.4.1 Food inflation trends

Since 2000, South Africa has been using an inflation-targeting monetary framework. The Central Bank sets and announces an inflation target within a specified range (3%–6%) and implements policies directed at achieving that target. South African Consumer Price Index (CPI) averaged at 4.5% in the 1940s, 3.8% in the 1950s, and 2.6% in the 1960s. It then increased to double digits in the 1970s (10%) and 1980s (16.6%) (Rangasamy, 2011). Double-digit inflation rates were influenced by South Africa's isolation periods from the rest of the world and policies that promoted non-competition practices (Rangasamy, 2011). Since the deregulation of agricultural markets, the inflation rate declined below a two-digit figure for the first time in two decades and there was also a decline in food-price variability (Vink, Tregurtha, & Kirsten, 2002). Between 1998 and 1999, the overall inflation had declined until July 2001, when it started to increase. Figure 2.6 below highlights South African food and overall inflation rates in the period from 2003 to 2018. Both overall and food inflation have shown increases over time, with food CPI increasing more rapidly.

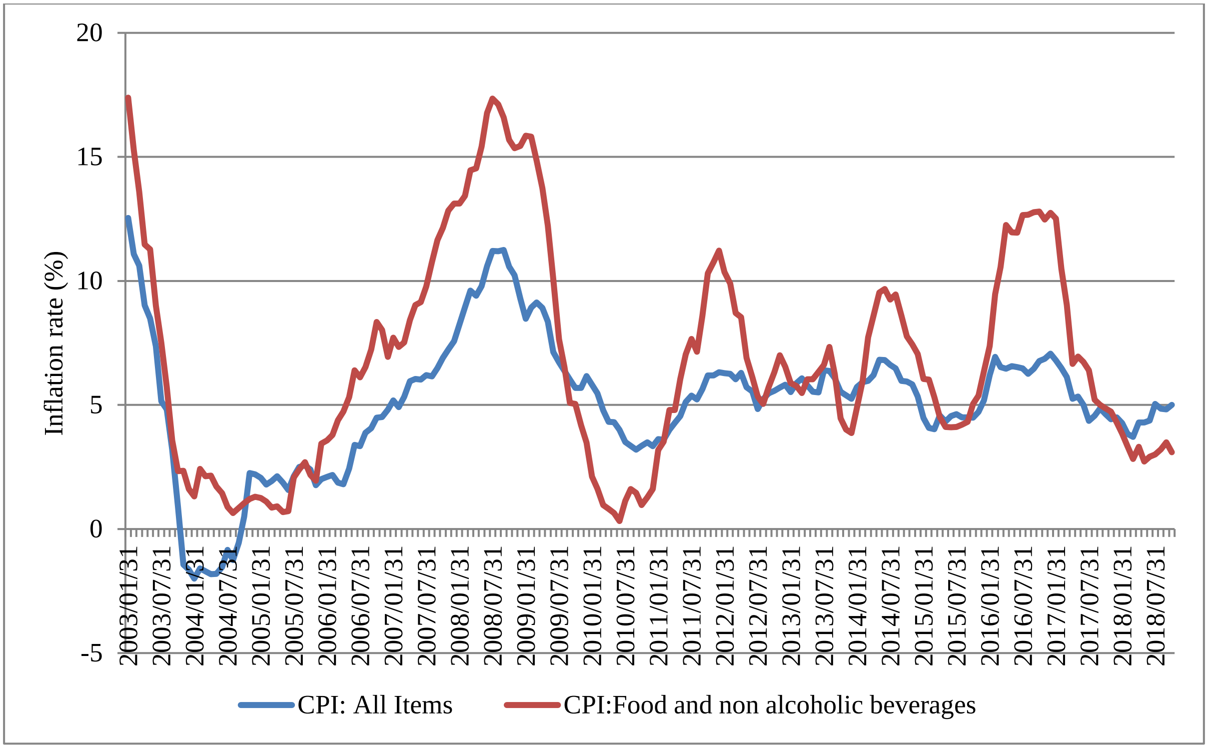

Figure 2.6: South African historical Inflation Trends

Source: StatsSA (2018)

Concerns over food prices are important as these prices constitute approximately 20% of the South African headline CPI (StatsSA, 2017). This is a significant share and thus highlights the importance of food in determining aggregated price increases (van der Heijden & Tsedu, 2008). According to Rangasamy (2011), the contribution of food to the headline CPI has significantly increased over the past two decades. Although correlation does not imply causality, Figure 2.6 suggests that food prices play a pivotal role in South African inflationary pressures.

According to StatsSA (2017), the average South African spends approximately 14.4% of their income on food and non-alcoholic beverages. Lower income groups, which constitute approximately half of the South African population, would be most affected by food price increases, considering that 28% – 31% of their income is spent on food (Greyling, 2012). Van der Heijden and Tsedu (2008) stated that very poor South African consumers spend approximately 80% of their income on food. Van der Heijden and Tsedu (2008) highlighted the point that the poorer the consumers are, the higher their share of income spent on food will be, and the more likely they would be to feel the impact of food inflation that exceeds the rate at which their wages are increasing.

Given the composition of food CPI, meat comprises the largest component, followed by bread and cereals, for South African consumers. However, for poorer households, maize is of higher importance in terms of affordability and frequency of consumption than the consumption of meat is. According to StatsSA (2017), South Africa's poorest households spent close to 33% of their expenditure share on food to purchase cereals, i.e. maize meal, bread, rice and wheat. Maize price implications are of particular importance as maize forms a large-scale food product in urban and rural areas (van der Heijden & Tsedu, 2008).

Considering that the share of the contribution by the agricultural sector to the GDP has been on a downslope since the 1960s, the sector still plays an important role in the economy. Although its contribution to the GDP in 2014 was approximately 2.5%, BFAP (2016a) highlights the point that its influence on food security in terms of affordability and availability cannot be understated. Most basic food staples were negatively affected by the drought, and this has led to South Africa importing considerable values of maize. Purchases of staple food account for approximately 25% of total consumer expenditure, with this share increasing for lower earning households (BFAP, 2016a). Moreover, inflationary pressures resulting from drought are expected to have the most immediate impact on grains, cereals and vegetables retail prices.

2.4.2 Maize meal price trends

This section highlights maize meal price trends and historical prices of some starch alternatives available to South African consumers, as presented in Figure 2.7 below. It is clear that maize meal prices are below the price levels of bread flour and rice. This is attributed to the fact that South Africa produces large volumes of maize, while producing relatively smaller quantities of wheat, thus relying on imports to meet the surplus domestic consumption of wheat products. Moreover, South Africa does not have adequate fresh water resources for the production of rice, thus the absolute reliance on other countries for rice imports.

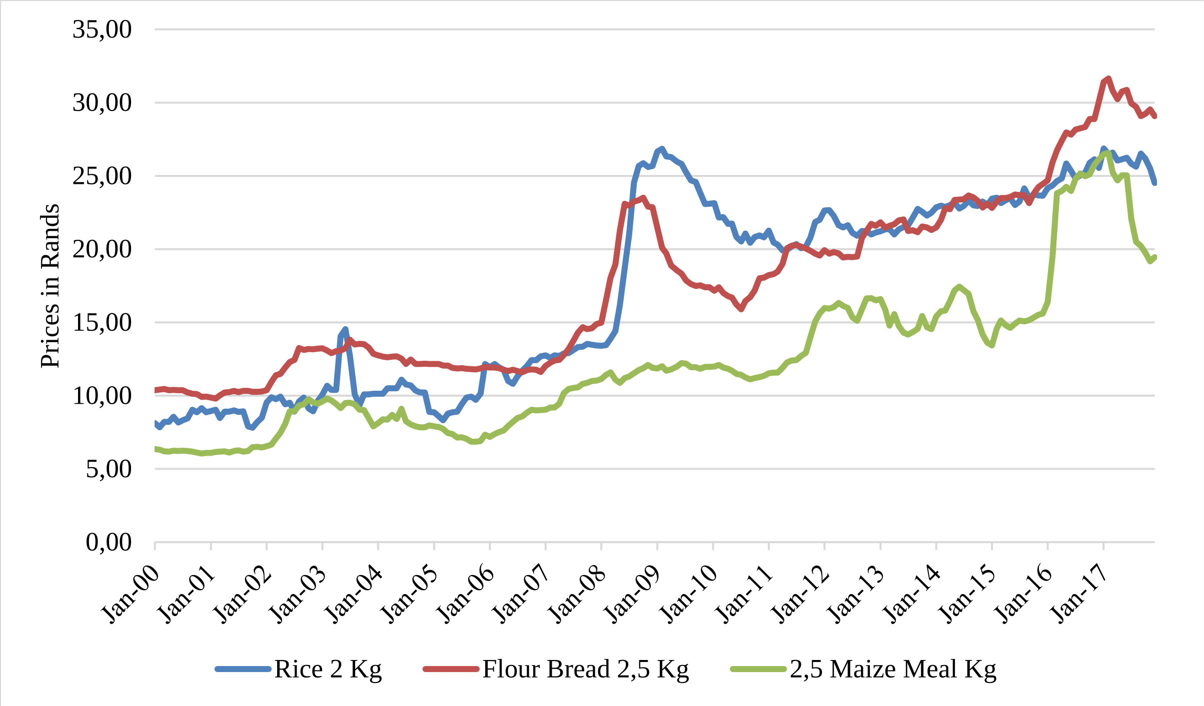

Figure 2.7: Historical prices of staples

Source: StatsSA (2017)

Figure 2.7 suggests point that the majority of the population, particularly the poor, consume more maize meal, given lower maize meal prices, than other staples.

2.5 SOUTH AFRICAN POOR CONSUMERS

This section gives an overview on poor consumers in South Africa and their food consumption patterns in comparison with non-poor consumers. According to StatsSA (2017) using 2015 prices, the poor are those who earn below an average of R992 PPPM (Per Person Per Month), thus those who earn above that are considered as non-poor. Approximately 34% of all South African households depend on social grants, while 61% of poor households rely on social grants for their livelihood.

As highlighted in Figure 2.8 above, in 2015 the majority of South Africans are poor (45%), even though their numbers have declined in comparison with 2006. StatsSA (2017) attributes the decline in poverty to the payment of government social grants, which are increasingly becoming a source of income for poor households.

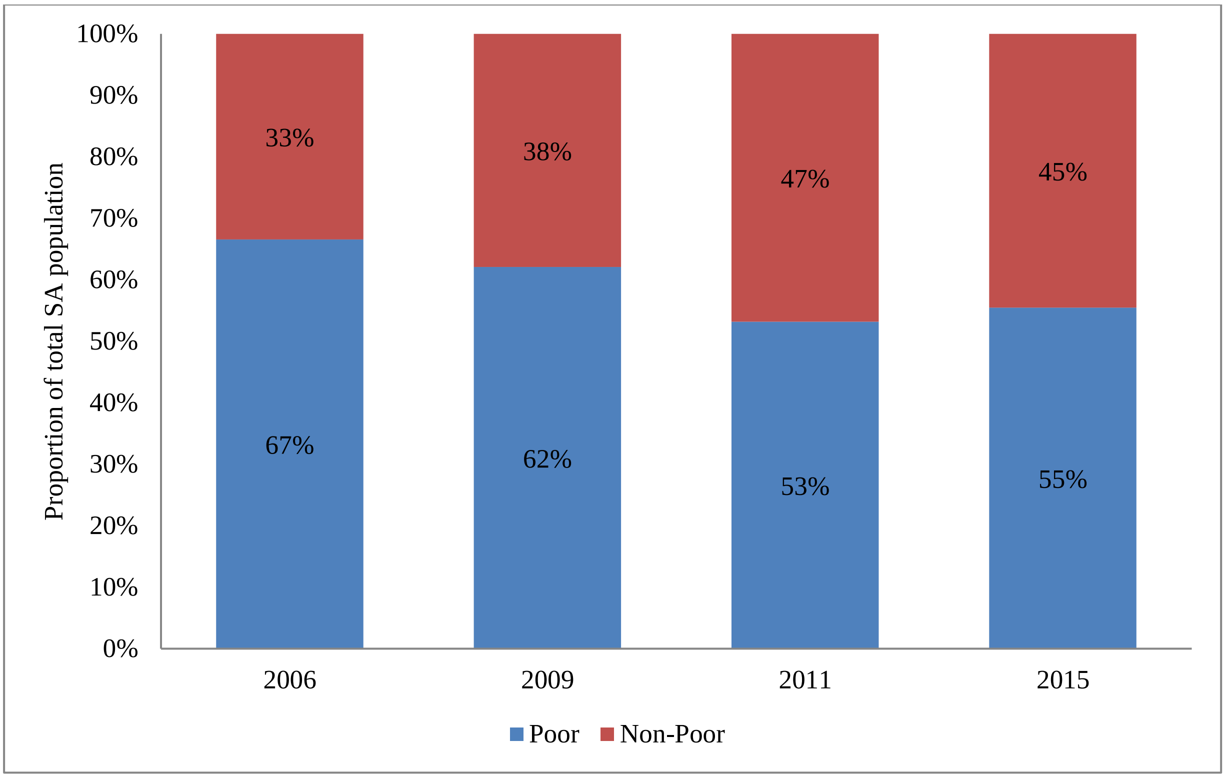

Figure 2.8: Proportion of poor and non-poor South African persons

Source: StatsSA (2017)

StatsSA (2017) uses three poverty lines to capture the degrees of poverty in the country. These poverty groups are known as the food poverty line (FPL), the lower bound poverty line (LBPL), and upper bound poverty line (UBPL). The food poverty line indicates households that are unable to purchase adequate food to meet their minimum daily energy requirement. The remaining poverty groups use FPL as a base and also consider non-food items. Therefore, lower bound poverty line households do not have the purchasing power to buy both adequate food and non-food items. Therefore, some households sacrifice food items to purchase essential non-food items. Households which fall under the upper bound poverty line are able to purchase both food and non-food items.

Figure 2:9 therefore highlights the proportions of poverty groups in South Africa. The majority of poor South Africans, approximately 13.8 million persons, do not have adequate income to purchase adequate food items, earning an average of R441 PPPM in 2015. The number of individuals who fall within the LBPL decreased from 10.7 million persons in 2006 to R8.1 million persons in 2015, earning an average of R647 PPPM. Approximately 8.5 million poor South Africans fall under the UBPL, receiving an average income of R992 in 2015.

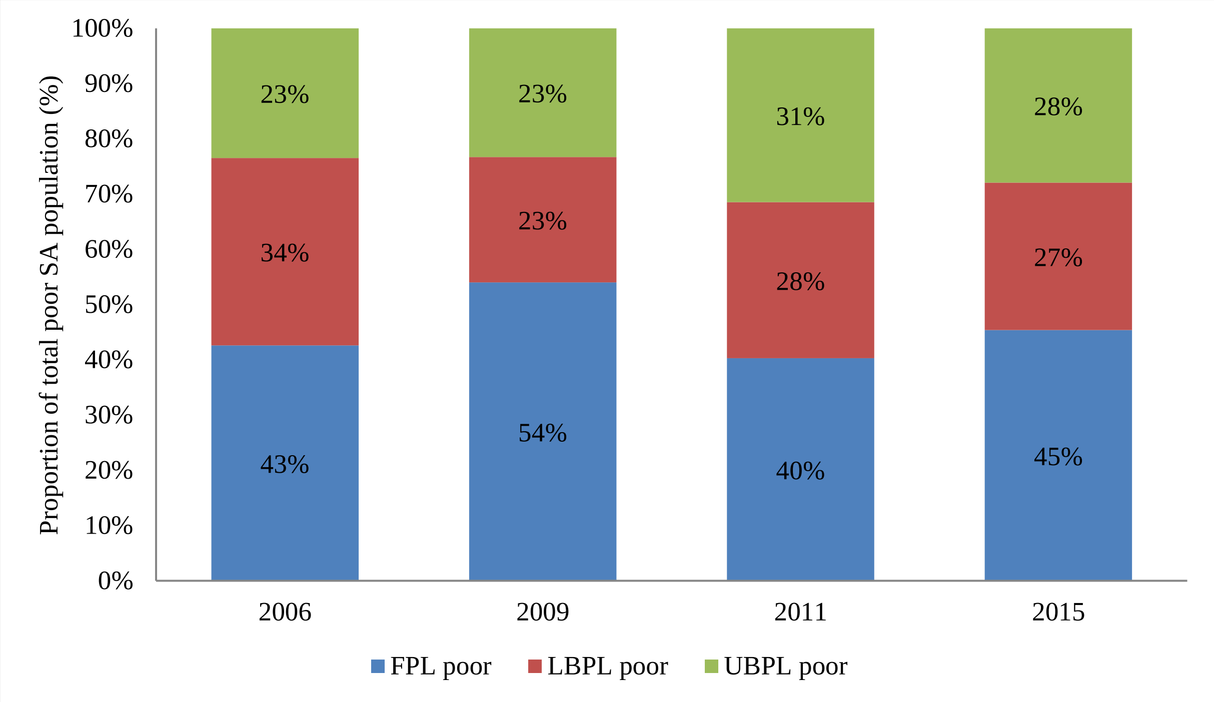

Figure 2.9: Proportion of Poor South African persons

Source: StatsSA (2017)

StatsSA (2017) highlight the fact that between 2011 and 2015, due to the economic pressure that South Africa faced, more numbers of households were pulled into poverty. Also, the rapid changes, i.e. zigzag movements in the household poverty levels, indicate the importance of policies that are directed at addressing food security challenges, especially when a country is faced with climate change and water shortage challenges (StatsSA, 2017).

Poor and non-poor South Africans have different expenditure trends, as highlighted in Figure2.10. In 2015, poor households spent approximately 30% of their income on food, and this had increased by 7% since 2006. However, non-poor households spent only about 10% of their income on food, and this had remained unchanged since 2006. Poor households spent the largest share of their income on bread and cereals, while non-poor households spent a large of theirs share on meat and fish.

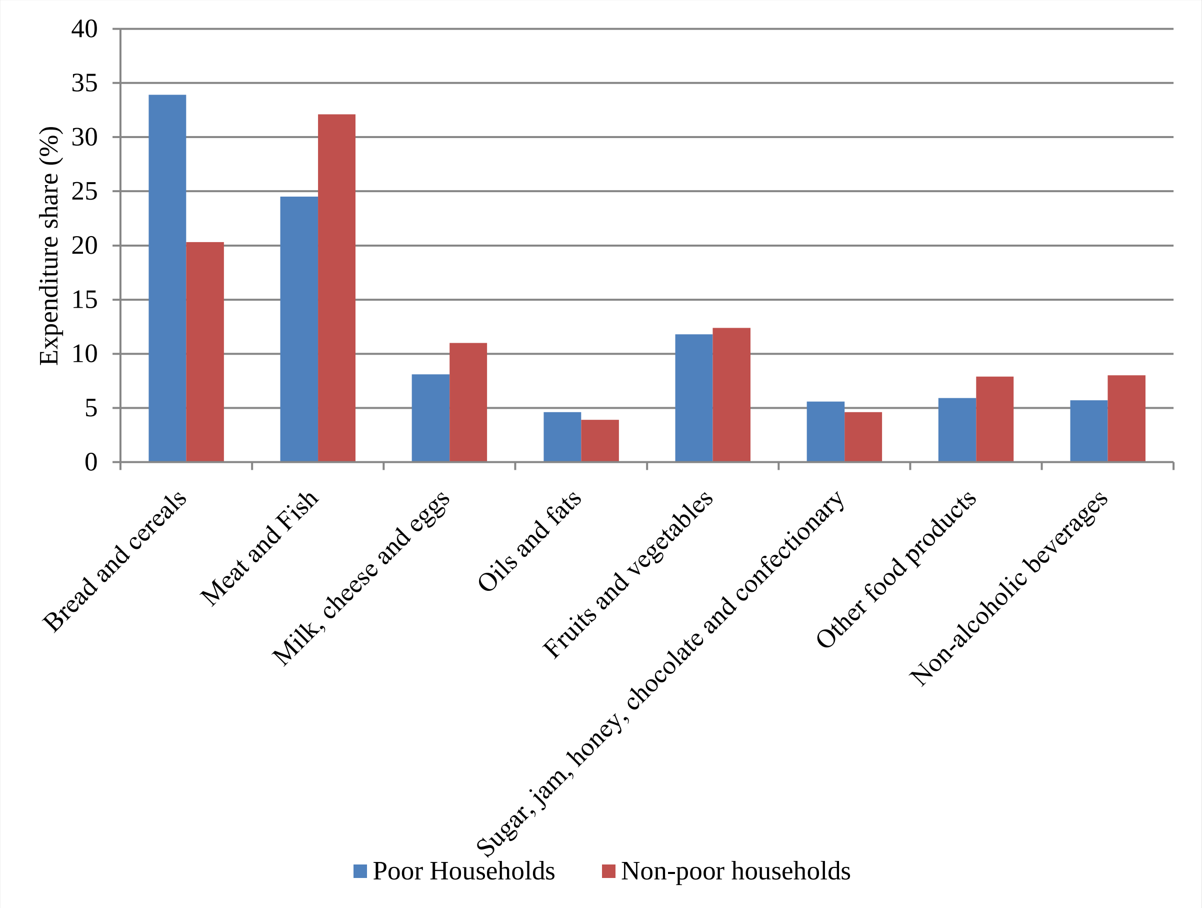

Figure 2.10: Proportion of average spending on food items by poverty status

Source: StatsSA (2017)

Maize meal ranks second on the list of food items that the poor spend their income on, after poultry (BFAP, 2016b). It ranked third after poultry and beef for the upper middle class, while it ranked 13th for the wealthy 20%.

Further, Table 2.1 below highlights the point that maize meal is the most important to poor households. This group comprises approximately 55% of the South African adult population, with an income share of 32% (BFAP, 2016b) (StatsSA, 2017).

Table 2.1: Top three average proportions of expenditure on food by poverty status

Poor Households	**Non-Poor Households**
Poultry 13.8% (11.1%)*	Poultry 11.1% (13.8%)
Maize meal 11.3% (3.8%)	Beef 8.2% (3.6%)
Brown bread 8.1% (4.4%)	Other food products 7.1% (4.7%)

Source: (StatsSA, 2017)

**Figures in parenthesis show the share of the other group, i.e. poor (non-poor)*

Poor households spend approximately 11% of their food expenditure on maize meal. This is a significantly high share in comparison with other cereals. Thus, any factors that cause a change in the price of maize meal greatly affect poor consumers more than non-poor consumers.

2.6 SUMMARY

Definitions of drought vary across regions of different economies. A threshold is used to differentiate drought periods from non-drought periods. Therefore, drought in the South African context is defined as any period wherein rainfall is below the long-term annual average of 600 mm. In South Africa, drought has recently increased in both severity and frequency.

Drought has differing effects on an economy, depending on the country's reliance on the agricultural sector. Those countries that have agriculture as contributing a larger share to their GDPs are more affected by drought, as it has primary linkages to that sector. South African maize production is greatly affected by drought, given that 83% of white maize is produced under dry land farming. In 2015, a 30% decline in South Africa maize production was mainly attributable to the most severe drought since 1904. This decline in maize has had negative impacts on South African food security.

According to StatsSA (2017), approximately 55% of the adult South African population is poor. The poor are categorised as being those who earn in an average range of between R441/month and R992/month, using 2015 prices. Poor consumers spend approximately 30% of their income on food, as compared with the 10% spent by non-poor consumers. Poor consumers spend a larger share of their food expenditure on bread and cereals, with maize accounting for the largest share (11.3%).

This highlights the importance of maize meal for poor households. Given that drought is a recurring phenomenon in South Africa, and the fact that white maize is predominantly produced on dry land, this greatly affects maize production. Price changes that arise from the effects of drought will thus have a negative effect on poor consumers, given their heavy reliance on maize meal.

CHAPTER 3

PRICE TRANSMISSION AND THE STUDY THEORETICAL FRAMEWORK

3.1 INTRODUCTION

Price is a mechanism wherein markets are linked (Goodwin & Holt, 1999); therefore, commodity price shocks from the farm and the wholesalers are passed through to consumer prices. The relationship between farm and retail prices gives an insight into the marketing efficiencies, along with farmer and consumer welfare (Aguiar & Santana, 2002). The fundamental reason for analysing agricultural markets is to gauge the extent to which several players along the value chain respond to changes in the commodity or farm prices (Rapsomanikis, et, al., 2003).

Price transmission studies contribute to the understanding of the relationship between commodity and retail prices, which is beneficial in understanding and addressing social and political concerns of the extent at which prices are transmitted at different points of the value chain (FAPRI, 2013), particularly during periods of price increases (Mkhabela & Nyhodo, 2011). This is particularly important as the lower-income groups that constitute approximately half of the South African population would be most affected by food price increases, considering that 28% to 31% of their income is spent on food (Greyling, 2012) and rely on social welfare. This background provides reasons as to why agricultural economics have over the years focused on farm-to-retail price transmission process. Moreover, many studies have shown that asymmetric price transmission is very common in the agribusiness sector.

Food price shock effects in developing countries receive attention, as sustained food price increases have a significant impact on the prevalence of poverty. Commodity prices set in a competitive market react immediately to macroeconomic events, whereas wholesaler and retailer prices take time to adjust. This implies that wholesale and retail prices are affected with a lag by any price changes from commodity prices. (Ferrucci, Jimenez-Rodriguezm, & Onorante, 2010)**.** Price transmission between food markets is central in evaluating the impact of price shocks on producers and consumers, and understanding how they respond to such shocks (Rapsomanikis, 2011).

As discussed earlier in Chapter 2 of this study, drought has several socio-economic impacts. Accordingly, this chapter provides a theoretical framework linking the impact of drought on consumer's income. Furthermore, the theoretical framework explains how a delay in price adjustment leaves consumers worse off, particularly during a recovery period. The chapter first outlines the theory of price transmission and consumer choice. Then, consumer theory is augmented to form the theoretical framework of the study by outlining the impact of asymmetric price transmission on consumer choice. The essence of the chapter is to relate econometric results and recommendations of the study with sound economic theory.

3.2 PRICE TRANSMISSION

Price transmission centres on these three main aspects; firstly, asymmetric behaviour in price which assesses if there are any differences between increasing and decreasing prices. Secondly, the time lag, wherein the duration of price changes transmitted to the next market level is observed. Lastly, the magnitude of the price change, where the value of the price passed onto the next market level is estimated. The extent of market efficiency can thus be determined once these three aspects are estimated. Asymmetric price transmission takes place when "players with market power transmit slowly price changes that benefit them while transmitting faster price changes that are a cost to them" (Mabaya, 1998).

Studies on vertical price transmission have gained much attention among researchers. The main aim of conduction vertical price transmission studies is to determine price linkages between different stages of a marketing chain and the speed at which price changes of one point of the value chain is reflected at another point (FAPRI, 2013). These studies provide a better understanding of a functioning of the market and how prices are determined from producer to wholesaler and to retailers (Mkhabela & Nyhodo, 2011). Therefore, the degree with which prices changes are transmitted along a value chain reflect the level of competition in a market.

Asymmetric price transmission takes place when the producer price decreases, but this decline is not passed on to the consumers fully or it reaches them at a slow pace (Rezitis & Pachis, 2016). According to FAPRI (2013) whether price changes are positive or negative, the rate at which price shocks are transmitted should be the same towards a long run equilibrium. Therefore, asymmetric price transmission conveys inaccurate information to producers and consumers (FAPRI, 2013). It over estimates producer and consumer benefits in a case where producer prices are not immediately of fully transmitted to consumers (Mkhabela & Nyhodo, 2011)

An equal price link along different stages of production may be challenging to detect (Ferrucci, et al., 2010). Commodity price movements may be expected to be passed down along price chains, and they may have a positive relationship with wholesaler and retail prices (Ferrucci, et al., 2010). The degree and the speed of adjustment at which the price shocks are transmitted among producers, wholesalers and retail prices are of importance in reflecting the actions of market participants at alternative market levels (Goodwin & Holt, 1999). Literature has shown that a significant lag exists in price adjustments at various marketing channel levels (Goodwin & Holt, 1999).

The absence of market integration or incomplete price transmission from one market to the other has implications for economic welfare (Ferrucci, et al., 2010). Most developing countries are subject to partial price transmission, due to policies and high transaction costs (as a result of poor transport and communication infrastructure). Poor transmission leads to a reduced availability of price formation information for economic agents, and leads to responses that are less elastic in demand and supply.

According to Goodwin and Holt (1999), lags in price transmission may be due to adjustment costs which inhibit adjustments in the market prices. Farm prices have been found to be unresponsive to price shocks in wholesale and retail markets, while retail markets are more responsive to price shocks from the farm level. According to Ward (1982), those in possession of perishable agricultural goods may resist increasing their prices because they fear that their products will not be sold and may be spoiled. Price leadership roles characterised by major buyers and sellers who trade under imperfect competitive markets underlie price asymmetry adjustment. As stated by Ferrucci et al. (2010), this may be due to, firstly, higher input costs not being passed on to consumers, when the shock is absorbed through advances in productivity. Secondly, in some instances, commodity prices make for insignificant prediction of inflation if consumer prices are affected by several shocks at a time. Lastly, the existence of non-linearity in price transmission also makes detecting positive correlation difficult.

3.3 CAUSES OF ASYMMETRIC PRICE TRANSMISSION

Asymmetric price transmission occurs due to several reasons, although the most common ones are non-competitive market structures and transaction costs.

i. Market power

Due to high industry concentration beyond the farm gate, it is common that the middleman is likely to use market power to employ pricing strategies which result in the incomplete and rapid pass-through of cost increases, but a slower and less complete transmission of cost saving (Kinnucan & Forker, 1987)**.** Further, Ferrucci et al. (2010) state that collusion among domestic traders and oligopolistic behaviour in the domestic market may keep price differences between the producers, wholesalers and retailers on a level higher that those determined by transport costs. Thus, imperfect competition and concentration in the marketing and processing sectors may imply that the processor and/or the middleman have power over prices. Furthermore, their pricing strategies may result in a quick and complete pass-through of increased commodity prices, yet slow or incomplete pass-through of decreases in the commodity prices to wholesale and retail prices, as their price margins are squeezed. The combination of oligopolistic behaviour and collusion among traders retains differences in domestic prices at levels higher than those determined by transfer costs (Goodwin & Holt, 1999).

Brito, Pereir and Vareda (2016), in their study, highlight the fact that under duopoly, the separation of ownership and control that causes information asymmetry has the following effects on the owner's incentives to reduce efforts. Firstly, it increases marginal costs of inducing effort, which leads to a decrease in efforts, and increases prices. Secondly, it leads to increased prices across all firms and to a change in the expected demand of each firm, and thus marginal benefit of inducing effort, which may amplify or mitigate the initial impact.

Market power is often expected to lead to positive asymmetry. Further, Meyer and von Cramon-Taubadel (2002) substantiate the view that it is expected that increased input prices will lead to reduced marketing margins, which will be transmitted more rapidly and completely than decreases due to market power are. However, is it not theoretically clear whether market power leads to a positive or a negative price transmission. A positive price transmission will result if a firm perceives that no competitor will match any price increases, yet will match a price cut. Also, a negative price transmission will result if the firm speculates that all firms will match price increases, but none will match a price cut (Meyer & von Cramon-Taubadel, 2002).

Additional work related to market power and price asymmetry is seen in the studies by Alemu and Worako (2011), where they analysed price transmission in the Ethiopian coffee market among farmers, auctions and world price. Price asymmetry was attributed to the presence of increased numbers of market players after market reforms. Furthermore, the coffee value chain is comprised of companies that source coffee from farmers (known as sebsabis) and from those who purchase coffee from the sebsabis (known as akrabis) and supply to auctioneers. Some companies have a license to operate as sebsabis and akrabis, which creates an unfair market advantage over others companies.

Similarly, a study was conducted by Chisanga, Meyer, Winter-Nelson and Sitko (2016) where they analysed market performance of the sugar industry since market liberalisation. Despite the fact that Zambia is a low-cost sugar producer, domestic sugar prices exceed the world price. Market power was cited as one of the reasons behind asymmetric price transmission, as there are only three sugar companies operating in Zambia, with one having a total sugar production share of 92.5%. Moreover, the existence of few firms in that value chain is attributable to the fact that sugar production requires heavy investments. This creates a barrier to entry, with very little market competition.

ii. Adjustment and menu costs

Adjustment and menu costs also account for some of the market price asymmetries. Adjustment costs arise when a firm increases or decreases its price or output levels (Meyer & von Cramon-Taubadel, 2002). These result from uncertainty of whether frequent price changes are transitory or permanent and thus an incomplete price transmission (Serra & Goodwin, 2003). If costs are asymmetric in line to the subsequent increases and decreases of price and or output, the adjustments will result to asymmetries. Thus, in regard to price changes, adjustment costs are also known as menu costs.

iii. Implementation of policies

Rapsomanikis (2011) highlights the fact that government intervention regarding food commodity sales or procurement and inventory management is very common in African and Asian countries. These measures hinder price transmission, given a government’s targeted price, its budget, capacity and ability to purchase and manage these food commodities, while continuously trading. Brümmer et al., (2009) studied vertical integration of Ukrainian wheat and flour prices. Their findings showed that the wheat-flour market is price asymmetric, and an underlying reason for this is the interference in this market by policy makers. This led to difficulty arising among private actors like farmers, millers and traders in planning consistently, thus leading to asymmetric price transmission. Chisanga et al. (2016) found that a policy implemented by the Zambian government, which that required sugar be fortified with vitamin A in the local market, resulted in quality differentials and hence incomplete price transmission in the Zambia sugar market.

iv. Transport and marketing costs

High transport and marketing costs increase domestic markets with large margins. In the case of developing countries, this is caused by poor infrastructure, transport and communication services, which leads to high costs in delivering commodities to the retailers for consumption. Thus, these high costs impede price signals of transmission. As a consequence, producer prices are not transmitted to the wholesale and retail markets, leading to other players along the food chain to adjust partially. A study conducted by Chisanga et al. (2016) argues that the Zambian sugar market is subject to high marketing costs arising from weak domestic infrastructure.

3.4 STUDIES ON PRICE TRANSMISSION

In their study, Cutts and Kirsten (2006) investigated price transmission asymmetry in four agro-food industries, namely maize to maize meal, sunflower to cooking oil, wheat to brown bread, and producer milk to long life milk and fresh milk. Their study was formulated due to the suspicions from the government and consumers concerning possible market power manipulation by certain role players. When commodity prices declined after food price hikes in 2002 and 2003, retail prices responded slowly. Using an Error Correction Model, Cutts and Kirsten (2006) highlighted the fact that asymmetric price transmission existed for all the food chains analysed. Retail prices for all the food industries did not react within one month to price changes of respective producer prices. Furthermore, retailers or the processors responded more rapidly to squeezed margins than when they are stretched.

Louw, Meyer, and Kirsten (2017) in their study analysed vertical price transmission in the South African wheat-to-bread and white maize-to-maize meal marketing chain. Their study finding are in contrast with those of Cutts and Kirsten (2006). It was found that in the wheat-to-bread and white maize-to-bread marketing chain, there was full price transmission and symmetry was evident. It is further stated that this does not rule out the possibility of uncompetitive behaviour in both markets. Also, wheat comprises only a fifth of total cost of bread, thus other components should be considered to ascertain the absence asymmetry given those other components.

Uchezuba (2010) also investigated the possibility of market power being an explanation for price asymmetry in the South African agro-food chains. The author used a threshold autoregressive (TAR) and a momentum threshold autoregressive (M-TAR) models to investigate price asymmetry, more specifically for the poultry industry. It was found that price asymmetry existed in the poultry industry, where if price shocks were negative, retail prices responded more rapidly that when the price shocks were positive. Moreover, retailers responded within distributed lags to any price shocks, as opposed to a complete and an immediate response. Uchezuba (2010) further stated that retailers depend on events at the farm level in order to formulate their market expectation.

3.5 THEORETICAL FRAMEWORK OF THE STUDY

3.5.1 Consumer choice

Traditional economic theory assumes that households and individuals choose the best collections of commodities that are consistent with their limited resources (Becker, 1962). In determining the best preference, a utility function is used. The best consumer choice produces more utility than any other alternative does. Indifference curves are used to depict a combination of two goods that will provide a consumer with equal amount of satisfaction. A budget line is used to depict a combination of two products that a consumer can afford to purchase, given that consumer's income. In an attempt to obtain the highest utility, a consumer is constrained by income and prices of various goods and services. Thus, a consumer will be at an optimal level of consumption upon obtaining maximum utility, subject to constraints, i.e. income and price of the product.

Assuming that consumers spend all of their incomes on only two goods, food and non-food items, a budget line represents a constraint that they will face in attempting to satisfy their wants between food and non-food items. Furthermore, the quantity of the combination of both goods is limited by the consumer's income and the prices of the goods, as shown in Equation 3.1.

$$F_x Q_x + NF_y Q_y = I \qquad (3.1)$$

given F_x is the price of food items, $Q_x$is the quantity of food items, NF_y is the price of non-food items, Q_y is the quantity of non-food items, and I is monetary income of the consumer. Thus, the money spent on both food and non-food items is equal to the consumer's total income. This theory is plotted in Figure 3.1 below, where food items are plotted along the Y vertical axis and non-food items are plotted against the X horizontal axis. Q_0-Q_0 is the original budget line that represents the best collection, where the budget line is tangent to an indifference curve, U_0 at point A.

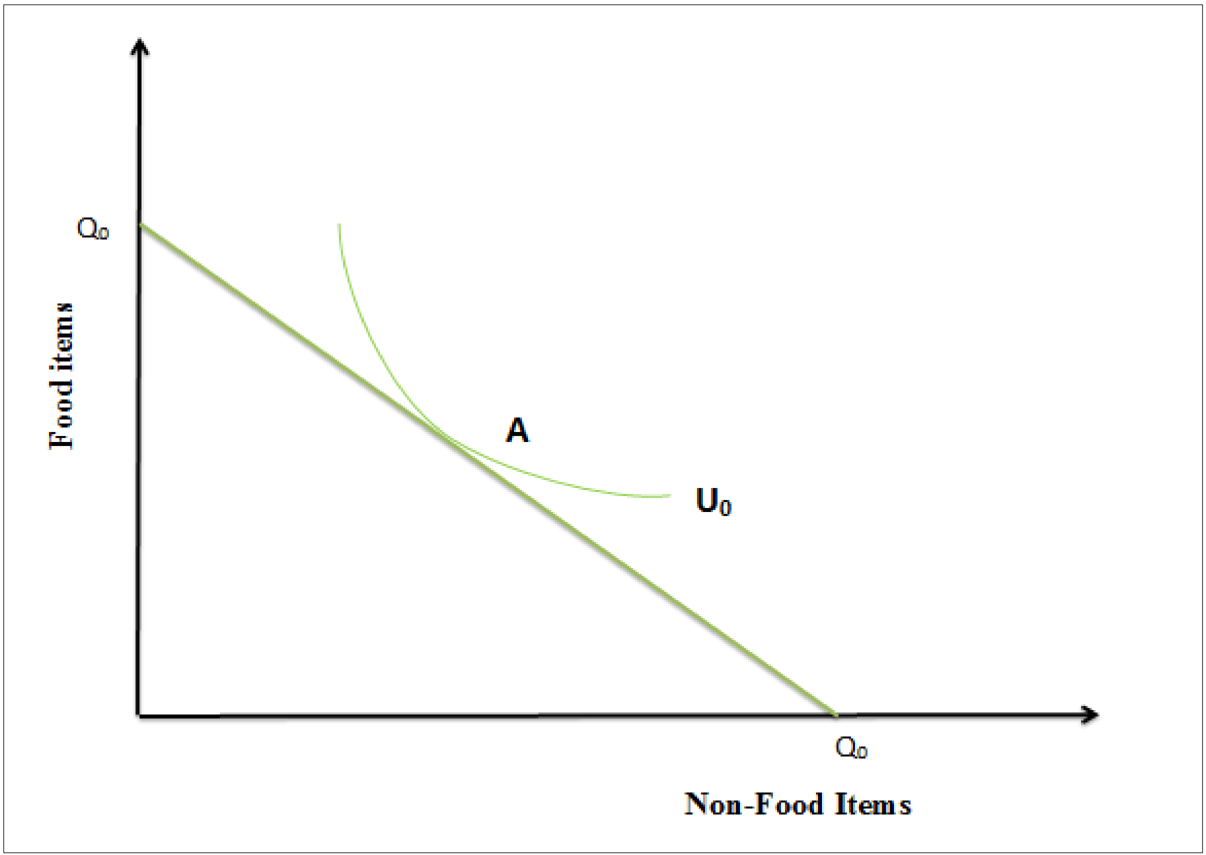

Figure 3.1: Consumer choice between food and non-food items

Any change in the consumer's income or the change in prices of any of the two goods would change the location of the best consumer choice. In an instance where a consumer's income increases (decreases), the budget line will move outwards (inwards), but the slope will remain unchanged. Given that only the price of food items changes, the Y intercept does not change, although the budget line will rotate upwards if F_x falls, or downwards if F_x increases. Furthermore, if the price of NF_y changes, the Y-intercept will remain the same, although the budget line will rotate upwards if NF_y falls, and down if NF_yincreases. This implies that when there is a change in the prices of either good, consumers will change the quantity of goods consumed accordingly, so as to spend within their budget.

3.5.2 Theoretical framework adopted for the study

Drought periods are characterised by a decline in agricultural production and higher food prices. Therefore, according to the consumer theory as discussed, the expected response is for the consumer to purchase fewer food items, while purchasing the same quantity of non-food items during a drought period. However, food consumption is price inelastic (Devereux, 2006), i.e. percentage increases in the food price do not trigger a greater percentage change in the quantity of food items demanded. This is particularly true for necessities, such as staple foods. Therefore, the study adopts an assumption that, given a hike in prices during a drought, consumers are expected to consume the same quantity of food items, purchasing fewer non-food items, while spending within their fixed income level. According to Becker (1962), this method is used to separate income from relative price effects. This adjustment supports a statement that poor consumers spend a large portion of their income on food (Greyling, 2012) (van der Heijden & Tsedu, 2008).

The theoretical framework of the study is represented in Figure 3.2 below**.** The period before a drought is an equilibrium point of the framework. Point A represents the equilibrium point, showing the levels of food and non-food prices before the drought period. At equilibrium, consumers are maximising their utility, as they are at the highest isoquant. It is assumed that at this point (A), a consumer is able to apportion income to purchase both adequate food and non-food items. An equilibrium period is then followed by a drought period, wherein prices of both food and non-food items increase. This causes a shift from point A to B. At point B, a consumer will apportion expenditure towards the same quantity of food items as in Point A. Based on the assumption of the study, consumers, more particularly poor consumers, will ensure that they purchase the same level of food items, while sacrificing non-food items, thus spending less on non-food items. This price change and adjustment moves consumers to a lower indifference curve, U_0 to U_1, making them worse off, in comparison with an equilibrium period.

After a drought period, i.e. a recovery period, prices are expected to decline due to a higher crop yields. Consumers are expected to return to Point A; however, due to the presence of asymmetric price transmission in the white maize market (Cutts & Kirsten, 2006), where "players with market power transmit slowly price changes that benefit them while transmitting faster price changes that are a cost to them" (Mabaya, 1998) prices do not return to their pre-drought level, i.e. they move from point B to Point C. During a recovery period, which is characterised by cost savings, prices may increase because of the presence of an asymmetric price transmission. As a result, they may not return to the original budget line, i.e. move from Q_0-Q_1 to Q_0-Q_2. Thus, a consumer is still at a lower indifference, U_2, in comparison with the original indifference curve at U_0. Therefore, when prices take longer in adjusting to equilibrium (i.e. returning to pre-drought conditions), the poor will remain much longer in the lower indifference curve with a reduced purchasing power. Price adjustment periods after a crisis, particularly those triggered by farm price increases, result in welfare losses for consumers, leaving them worse off.

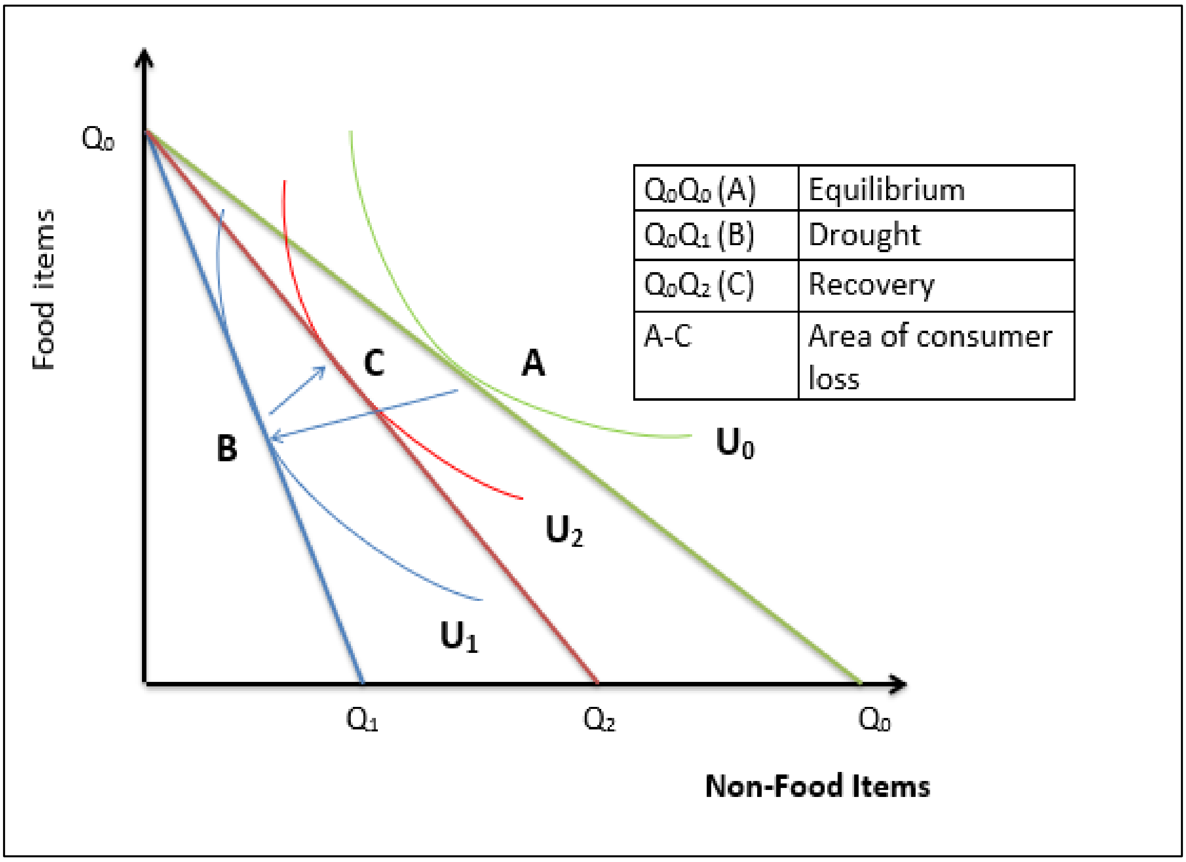

Figure 3.2: The impact of price change during a drought and a recovery period, and the derivation of the demand curve

Changes in consumer spending attributable to a delay in price adjustments after a drought period are summarised in Table 3.1 below.

Table 3.1: Change effect of price change during equilibrium and adjustment periods

	Equilibrium	Drought period	Recovery Period	Net Effects
Budget Line	Q_0-Q_0	Q_0 Q_1	Q_0 Q_2	Income remains the same; however, the consumers spend more of their income on food, i.e. same quantity of food items and reduced spending on non-food items.
Utility	U_0	U_1	U_2	Consumer is at a lower indifference curve

Adapted from Mohr and Fourie (2008)

For all the periods, pre-drought, drought, and recovery, the income of consumers, particularly poor consumers, remains unchanged. Thus, inflation would require them to adjust their expenditure patterns. For this study framework, a net effect of drought is that a consumer will shift from spending income on more non-food items to purchasing more food items. Furthermore, a drought leaves consumers at a lower utility.

3.6 SUMMARY

The study of market price highlights the extent to which value chain players respond to commodity price changes. Price transmission describes the process of how prices changes are translated from one point of the value chain to another. This process becomes asymmetric when players with market power slowly transmit the price changes that benefit them, while transmitting faster the price changes that are a cost to them. Asymmetric price transmission is caused by market power, adjustment and menu costs, implementation of policies, and transport and marketing costs, among other things.

This chapter also gives a background on the theory of consumer choice and a budget line, which are used as a theoretical framework in the study. The theory highlights the point that, before a drought period, consumers are at an equilibrium, where they can afford both food and non-food items. Once a drought occurs and food prices increase, consumers tend to purchase fewer non-food items in order to maintain their original quantity of food items bought. After a drought, i.e. in a recovery period, prices are expected to return to their equilibrium level. However, due to a delay in price adjustments, food prices during a recovery period remain higher than the equilibrium prices. Therefore, the theoretical framework of the study highlights the fact that the presence of sustained food price increases leads to consumer welfare loss.

CHAPTER 4

METHODOLOGY

4.1 INTRODUCTION

Chapter 4 of this study highlights the inferential methodologies used to address the objectives of the study. It outlines the sources of data used and their frequency. It also gives the reader a background to the importance of working with stationary variables and the types of unit root test techniques that are used. This chapter further provides an outline of the methods used to estimate long- and short-run equilibrium relationship between the variables. It also explains the method used to estimate price transmission behaviour for drought and recovery periods. The chapter concludes with a description of the diagnostic test performed on the error term to ensure that regressed relationships do not violate the Classical Linear Normal Assumption.

4.2 DATA SOURCES

This study analysed monthly white maize and maize meal prices from January 2000 to December 2017. White maize prices were sourced from the South African Futures Exchange (SAFEX) and maize meal prices were sourced from Statistics South Africa (StatsSA). White maize meal prices were originally sourced as daily prices and averaged to monthly values. White maize prices were averaged to monthly prices from weekly averages. Recovery and drought dummy variables were generated by using figures of long-term annual average rainfall sourced from WeatherSA (2018). Prices for a bag of 2.5kg maize meal were used due to the availability of the data for the analysed period in comparison with other quantities, i.e.10 kg and 12.5 kg bags, that most poor households are most likely to purchase. Using data from Weather SA (2018), dummy variables were used to separate drought from recovery periods as follows:

D=1 if annual average rainfall is below 600 mm and,

D=0 if annual average rainfall is above 600 mm

Annual average rainfall dummy variables were imposed on monthly white maize and maize meal prices.

4.3 STATIONARITY

Time series observations are stationary when their mean, variance and auto-covariance details remain unchanged, regardless of the point at which are they measured (Gujarati, 2004). Inversely, when a series has varying mean, variance and covariance over time, it is said to be non-stationary. It is, therefore, undesirable to work with a non-stationary set, as it will only be relevant for a particular period, making it impossible to generalise it over other time periods (Gujarati, 2004). Moreover, forecasting such a series would not be of practical value.

Spurious regression might also occur in the presence of non-stationary variables. Spurious regression normally has a high R^2, t-statistic that appears to be significant; however, the results of such a regression are without any economic meaning (Enders, 2010). Furthermore, when the R^2 is greater than the Durbin Watson (DW), it is an indication that the regression is spurious (Gujarati, 2004). Unit root testing, i.e. testing stationarity on economic time series variables is highly important for the purposes of policy. If an economic time series variable is asymptotically uncorrelated, then the value of that variable in the coming year or period is, at best, weakly related to its value in the previous periods (Wooldridge, 2013). This implies that any policy affecting that particular economic variable will have insignificant lasting impact. Inversely, if that economic variable is strongly dependent, the next period's observation of that variable will be correlated with observation from the previous periods (Wooldridge, 2013). Thus, a decision resulting in change towards such a policy may have long lasting effects.

The objectives for testing for stationarity are as follows: (1) to test if a random set, over time, is stationary or non-stationary (such tests are known as unit root tests), and (2) if a set is found to be non-stationary, to use statistical methods to make it stationary.

4.4 UNIT ROOT TEST PROCEDURES

This section highlights some of the procedures used in this study to test for the presence of unit roots and deterministic time trend. This study applied an Augmented Dickey Fuller (ADF) method, and the Phillips Perron (PP) procedure was used for robustness. Graphical representation was also used to informally predetermine the presence of non-stationarity.

4.4.1 Graphical Analysis

Gujarati (2004) advises that, before formal tests are pursued, time series data need to be plotted. The same was done for the observations in this study so as to get an initial indication regarding the nature of the set's stationarity. Sets show an increasing or a decreasing trend, over time, which suggests that the mean of the observation has been changing – thus non-stationary.

4.4.2 Augmented Dickey Fuller Test

This subsection highlights some of the procedures used in this study to test for the presence of unit roots and or deterministic time trend. Unit root was tested on the dependent (Y_t) and independent (X_t) variables. The Augmented Dickey Fuller procedure was used, and for robustness, this study applied the Phillips Perron procedure. The main goal for using the ADF is to clean up serial correlation in the y_t(dependent variable). Given the pth order autoregressive process:

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + a_3 y_{t-3} + \cdots + a_{p-2} y_{t-p+2} + a_{p-1} y_{t-p} + \varepsilon_t \tag{4.1}$$

Adding and subtracting $a_{p-1} y_{t-p}$ provides a better understanding of the ADF Test (Enders, 2010). This procedure augments the Dickey Fuller test by adding to the regression equation lagged values of the dependent variables. This is done so that there are enough terms in such a way that the error term is serially uncorrelated (Gujarati, 2004). Including too many lag variables to the regression may lead to a small power of the test. However, including too few lags leads to the size of the test being incorrect, and also asymptotic, due to the validity of the critical values on the dynamics being modelled (Wooldridge, 2013). Often, the lag length is prescribed by the frequency of the data: for annual data, one or two lags are sufficient, and for monthly data, 12 lags may suffice. The interest of this test is placed on the γ, if γ=0, this equation is in first difference and has a unit root.

Given the deterministic components in the regression equation, appropriate statistics were used. Where there is no intercept or a trend, the τ statistics was used; where there is just an intercept, the τ_μ statistics was used; and in the presence of both, an intercept and a trend τ_τ statistics were used (Enders, 2010).

4.4.3 Phillips Perron Test

The ADF test assumes that error terms are statistically independent and have a constant variance. Thus, the Phillips Perron Test formulates a generalisation of the Dickey Fuller Test. The PP procedure allows for mild assumptions of the distribution of the errors (Enders, 2010). It uses non-parametric procedures to take care of serial correlation in the error terms, without adding lagged difference terms (Gujarati, 2004).

The Statistical package used for this study (views version 10) has incorporated both the ADF and the PP tests. Cointegration is a formal test used by Engel and Granger (1978) which renders regression of I(1) variables such that they potentially have meaning.

4.5 COINTEGRATION

Early work on price transmission by Farell (1952) and Tweeten and Quance (1969) used cross-market price correlation or simple regressions to test the degree of market integration. However, the realisation grew that price series are often non-stationary, resulting in misleading statistical results, hence the popular use of cointegration methods (Balacome, 2007). Cointegration implies that, despite variables being non-stationary, a linear combination of two or more time series observations can be stationary (Gujarati, 2004). Thus, cointegration of time series variables suggests that there is a long-run, or equilibrium, relationship between them (Gujarati, 2004). In the short run, variables may drift apart because of seasonal reason (Townsend, 1998). Yet, in the long run, they may be brought together by factors such as market mechanisms and or government intervention (Townsend, 1998). However, there are two conditions that must be met for co-integration to hold. Firstly, individual variables need to be integrated of the same order. Secondly, linear combination of these variables must be integrated of an order less than the original variables (Alemu, Oosthuizen, & van Schalkwyk, 2003). Cointegration makes regression involving I(1) variables potentially meaningful (Gujarati, 2004).

Unit root tests results provide the order of integration, which is essential for cointegration tests i.e. I(0) or I(1) series. This ensures that regressed relationships of variables are integrated of the same order. Given:

$$y_t = \beta_0 + \beta_1 x_t + \varepsilon_t \qquad (4.2)$$

where y_t in the study is maize meal retail price, while x_t is the Maize Safex price for the maize agro-industry. These pair variables are cointegrated when an OLS regression yields consistent estimators of the cointegrated parameters, β_0, β_1. If individual series are non-stationary, and the error term is stationary, there exists a co-movement between y_t and x_t. If the series are stationary, then the long-run properties can easily be evaluated (Poonyth & van Zyl, 2000). Cointegration thus prompts the researcher to find out if the regression residuals are stationary (Gujarati, 2004).

To further determine if the variables in Equation 4.2 above are cointegrated, it was essential to denote the residual $\acute{\varepsilon}_t$ sequencing for equation, which is the estimated residual series of the long-run relationship. An ADF test was performed on the $\acute{\varepsilon}_t$ to test whether the residuals were stationary and to determine the order of integration. Thus, given:

$$\Delta \acute{\varepsilon}_t = a_1 \acute{\varepsilon}_{t-1} + \epsilon_t \qquad (4.3)$$

where if a_1 = 0, then the conclusion is that the residual series does not contain a unit root, thus confirming that y_t and x_t are cointegrated, i.e. the regression would be meaningful, showing a long-run relationship between the pair variables.

4.6 ERROR CORRECTION MECHANISM

The ECM was first used by Sargan in 1984, who estimated wages and prices in the United Kingdom, and this mechanism was later popularised by Engle and Granger in their concept of correcting disequilibrium (Gujarati, 2004). Engle and Granger postulated a Granger representation theorem which states that “if two variables Y and X are cointegrated, then the relationship between the two can be expressed as ECM”. Over the years, the ECM has gained popularity, which allows for validity of more restrictive partial adjustment model testing (Townsend & Thirtle, 1997). The ECM includes a dynamic component that captures the adjustment effect of the dependent variable when it deviates from the long-run equilibrium, unlike a static framework (Worako, van Schalkwyk, Alemu, & Ayele, 2008).

Given that the dependent and independent variables are cointegrated, their relationship can be expressed in an Error Correction Mechanism (Gujarati, 2004). According to Meyer and von Cramon-Taubadel (2002), Equation 4.4 and Equation 4.5 are translations of a supply response into a price transformation equation. The Error Correction Model is built as follows:

$$y_t = \beta_0 + \beta_1 x_t + \sum_{j=1}^{K} \left(\varepsilon_{t_1}^{-} D_1 \right) + \sum_{j=1}^{K} \left(\varepsilon_{t_1}^{+} D_1 \right) \qquad (4.4)$$

$$y_t = \beta_0 + \beta_1 x_t + \sum_{j=1}^{K} \left(\varepsilon_{t_1}^{-} D_0 \right) + \sum_{j=1}^{K} \left(\varepsilon_{t_1}^{+} D_0 \right) \quad (4.5)$$

D_0 and $D_1$are dummy variables, where:

D_1= 1; if annual average rainfall is below 600mm (drought), and

D_0= 0 if otherwise (recovery)

$\varepsilon_{t_1}^{-}$ represents negative error terms

$\varepsilon_{t_1}^{+}$ represents positive error terms.

The use of dummy variables in Equation 4.4 and Equation 4.5 splits the residuals into drought and recovery periods. Further residuals in each period are split into positive and negative values. Equation 4.4 will thus assess whether there is a difference in how white maize price increases and decreases are transmitted to retail prices for a drought period. A summary of Equation 4.4 is outlined in equation 4.6. Furthermore, Equation 4.7 examines whether price changes emanating from white maize prices are transmitted differently during a recovery periods.

$$y_t = \beta_0 + \beta_1 x_t + ECTD^{+} + ECTD^{-} \quad (4.6)$$

$$y_t = \beta_0 + \beta_1 x_t + ECTR^{+} + ECTR^{-} \quad (4.7)$$

$ECTD^{-}$ refers to Negative Error Correction Term during a drought period

$ECTD^{+}$ refers to Positive Error Correction Term during a drought period

$ECTR^{-}$ refers to Negative Error Correction Term during a recovery period.

$ECTR^{+}$ refers to Positive Error Correction Term during a recovery period

A difference in the Error Correction Term highlights the fact that price changes triggered by white maize prices are transmitted differently under drought and recovery period. This ECT has to be lagged, negative, and statistically significant to restore equilibrium (Gujarati2004). The Error Correction term is negative and less than one (Townsend, 1998) and thus its function is to push y back towards the point of equilibrium. Likewise, if $y_{t-1} < \beta x_{t-1}$, the Error Correction term brings about a positive change in y, back to the point of equilibrium. The Error Correction Term indicates the duration it takes for a shock that is causing disequilibrium to move through the system. The negative sign of the coefficient shows that the system returns back to equilibrium after an external shock, while the magnitude of the coefficient shows the duration required for the system to return to equilibrium (Davids, Schroeder, Meyer, & Chisanga, 2016). Also, because the ECM variables are stationary, this implies that the standard regression techniques are valid (Townsend, 1998).

4.7 DIAGNOSTIC TESTS

After establishing the short-run relationship, several diagnostic tests are necessary to be performed on the error correction model in determining whether any of the classical normal linear regression model are violated (Wooldridge, 2013) (Enders, 2010). The following tests, known as the “battery” of diagnostic tests, were performed for the study:

- **Normality test:** to check if the residuals are normally distributed with a zero mean and variance. Thus, OLS estimators will also be normally distributed. A Jarque-Bera test was used to test for normality of the errors.
- **Heteroscedasticity:** this occurs when the variance of the residual term is not constant over differing values of the explanatory variables. A White’s Heteroscedasticity test was used to test for heteroscedasticity.
- **Serial Correlation:** This test checked whether the error term is related to any observations. A Breusch-Godfrey LM Test was used to test for serial correlation.
- **Misspecification:** Misspecification results when there is inclusion of an irrelevant variable or the exclusion of relevant variable. A Ramsey Reset test was used to test for any misspecification

4.8 SUMMARY

This chapter described the methodology used to achieve the main aim of this study, which is to assess the effects of drought on price transmission along the South African White maize market. White maize and maize meal monthly data from January 2000 to December 2017 were collected from SAFEX and StatsSA, respectively. These variables were checked for stationarity using the ADF and Phillips Perron Tests. Once variables are stationary, and or are integrated of the same order, a cointegration test can be performed. A cointegration test shows that variables in the long run have a co-relationship. The error terms of the cointegration results are then separated to ECT-, for price decreases, and ECT+ for price increases. A drought dummy variable is used to further separate the ECT terms. ECTD+ and ECTR+ represent price increases for the drought and recovery periods, respectively.

Furthermore, ECTD- and ECTR+ represent price decreases for drought and recovery periods, respectively. These variables in their lagged forms, i.e. the Error Correct Terms along with differenced white maize prices are regressed against the maize meal variables to check for a short-run co-relationship. To ensure that the Classical Linear Regression Model is not violated, a battery test is then run on the error terms of the error correction model to ensure the validity of the results. Once the procedures of the cointegration and error correction model have been done, then the main objective of the study would be achieved.

CHAPTER 5

DATA ANALYSIS, RESULTS AND DISCUSSION

5.1 INTRODUCTION

The preceding chapters gave an overview of the study's problem statement, the objectives of the study, and the theoretical framework and structure of the methodology. This chapter serves to present the empirical results of the model. The findings of the study are divided into descriptive and inferential analyses. The descriptive analysis provided the explanation of price behaviour, particularly between drought and recovery periods, for the analysed time series variables. The inferential analysis provided regression results of the long- and short-run relationships for the selected variables. This chapter quantifies the relationship of commodity and retail prices for South African white maize.

This chapter is organised as follows: the first part outlines the descriptive analysis of the data used for the study. The second part outlines a series of preliminary time series data tests, and long- and short-run equations. The regression results are reported, followed by a discussion. The results of the model are then followed by the results of the tests performed on the residuals of the model. The third part outlines the effect of sustained price increases resulting from rainfall variability on consumers. The last part of this chapter presents a summary of the discussion in the chapter.

5.2 DESCRIPTIVE ANALYSIS

This section presents the analysis of the price behaviour of the white maize and maize meal variables and their variations over time. Descriptive results are presented with the use of tables and graphs.

5.2.1 Analysis of variables

This study uses monthly white maize and maize meal prices from January 2000 to December 2017. Their descriptive analysis is summarised in Table 5.1 below. For the study period, white maize prices averaged at R1 778.89/ton. White maize prices were at the highest value in December 2017, just after the worst drought period since 1904. Its lowest value of R504.33/ton was recorded in June of 2010, during a period when South Africa received good rainfall. Maize meal prices averaged at R12.24/2.5 kg. The highest value was observed in

February of 2017. This was 11 months after a period where white maize prices were also at their highest values. The lowest maize meal price of R6.05/2.5 kg was observed in November of 2010. The highest values of both the variables were observed just after the most recent drought period in South Africa.

Table 5.1: Descriptive summary of the observed variables

	White Maize R/Ton	**Maize R/2.5Kg**
Mean	1 778.86	12.24
Maximum	4 992.25	26.56
Minimum	504.33	6.05
Std Dev.	939.10	5.10
Observations	216	216

Source: Own Calculations

The observations of annual average values of the variable are represented in Figure 5.1 below. This figure also shows a positive relationship between the observed variables. Both variables have been on an increasing trend since 2000, with their highest prices being recorded in 2016 after the severe drought. In 2000, maize meal was, on average, R6.20/2.5 kg, and over the years, increased to R14.94/2.5kg in 2015.

Figure 5.1 below suggests that, on average, prices for both white maize and maize meal are higher during drought periods. However during a recovery period, the changes in prices largely depend upon the duration of the drought period. During a minimum two-year consecutive drought period, i.e. 2002–2003, 2007–2008 and 2012-2015, the recovery periods are characterised by a reduction in prices of both variables. However, for a short drought period, in this case a year (2005), the recovery period is characterised by increasing prices. After the 2007–2008 drought period, the recovery period was characterised by a reduction in the prices for two years, 2009–2010, and then afterwards, prices show a sharp increase in the prices until a drought then encourages a further increase in the prices. This suggests that the length of a drought period has an effect on the behaviour of the prices during a recovery period. Although the observation of this time series may not be sufficient to make a definitive conclusion, it is observed that short drought periods are followed by continued increases in prices, while longer drought periods are followed by declines in prices of both variables.

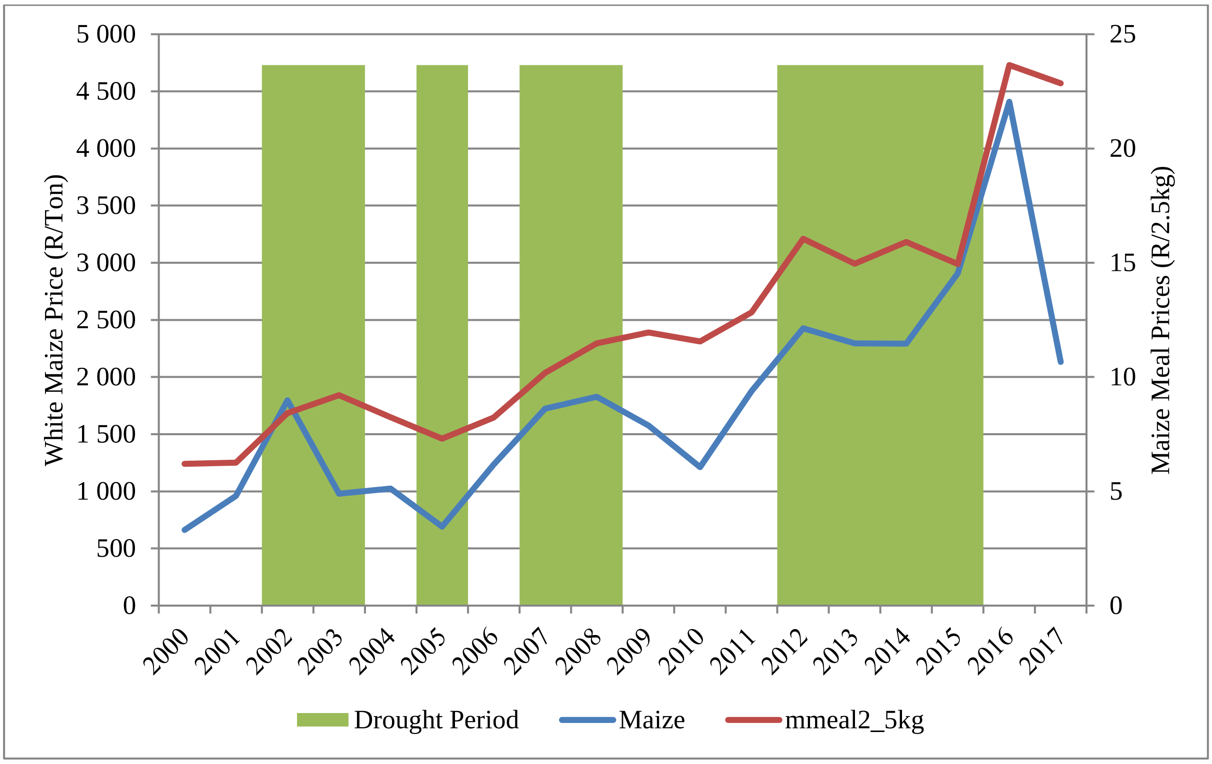

Figure 5.1: Annual average observation of white maize and maize meal prices, 2000–2017

Source: SAGIS(2018) and StatsSA(2018)

Figure 5.2 below shows the monthly mean prices for the period between January 2000 and December 2017. White maize prices are at their lowest during May, when maize meal prices are at their highest level, considering the first half of the year. White maize prices continue to increase until they reach a peak in December. Maize meal prices are at their lowest from January through to March. They reach a peak between September and December. Both variables are at their highest monthly average price in December. This method of observing price changes shows that seasonality in the maize market is evident. Also, this has an effect on the R^2, thus a low R^2 is expected in the inferential estimations.

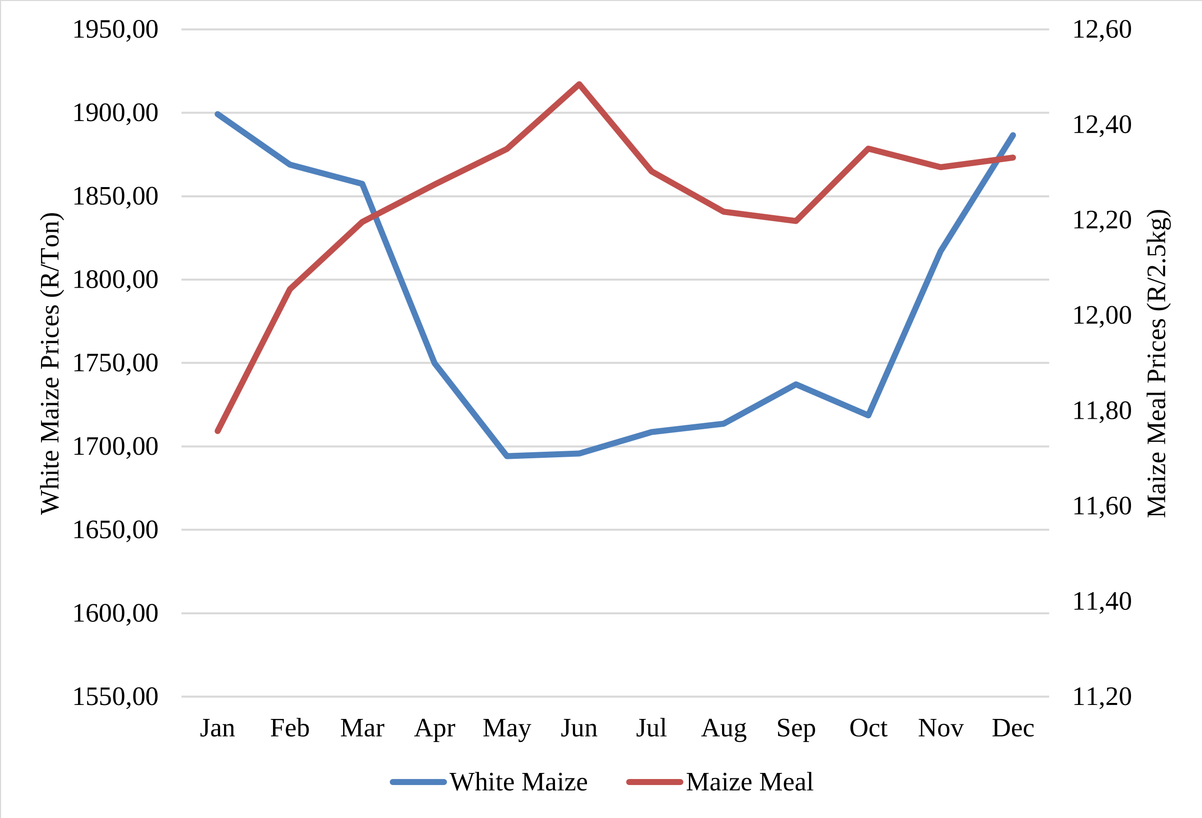

Figure 5.2: Monthly average white maize and maize meal prices, 2000–2017

Figure 5.3 below shows the average rate of price changes, i.e. price increases and decreases for both drought and recovery periods. The prices of variables continue to fluctuate during drought and recovery periods, as shown in Figure 5.3. During a drought season, white maize prices increase and decrease at the same rate. Also, white maize price changes during a recovery period only differs at a rate of 0.3%. This may suggest price symmetry for periods where rainfall is below 600mm. Retail maize meal prices also increase and decrease at the same rate during a recovery period. However there is a difference in maize meal price changes during a recovery period. The latter may suggest the possibility of price asymmetry once rainfall is above 600mm. However inferential analysis is needed to draw this conclusion.

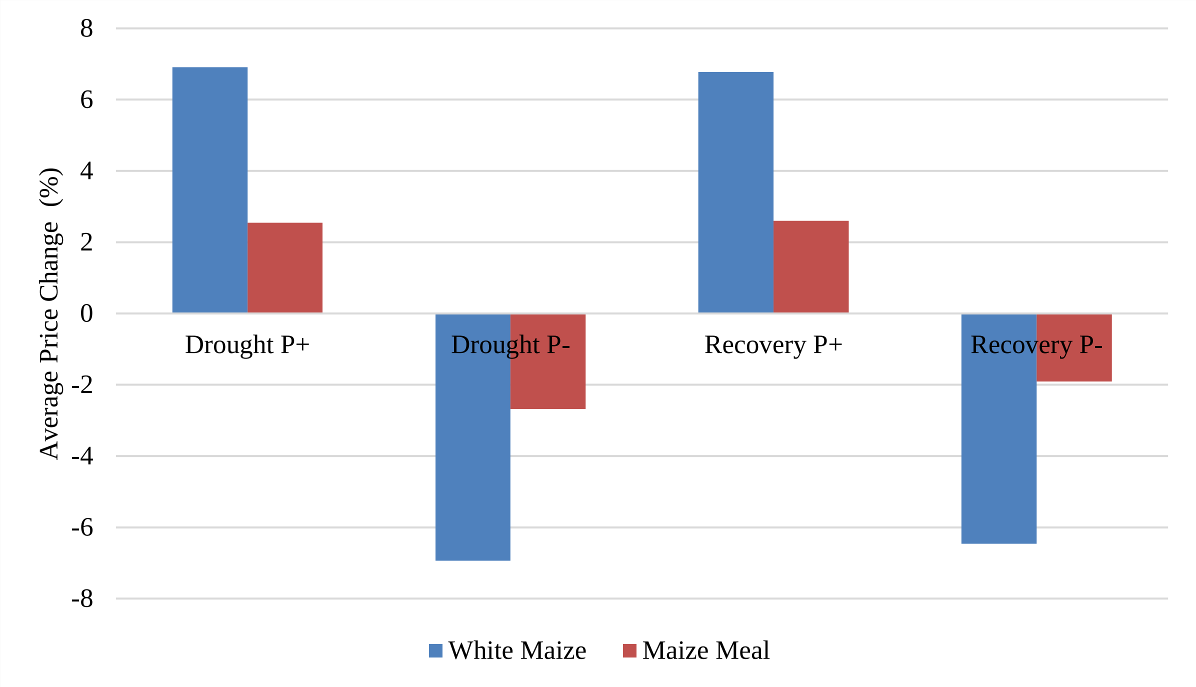

Figure 5.3: White maize and Maize meal prices during drought and recovery periods

There is a difference in the observations of price changes within both periods, which suggests asymmetric price transmission. White maize price increases during a drought period took place within 60 months, across the entire time series observation. These were higher than the drought price decreases over 47 months. The same is also true for maize meal price changes during a drought period. Price increases were observed over 61 months, as opposed to the 44 months of drought price decreases.

White maize price increase observations during a recovery period were higher (55 months) than price declines (52 months). This also applies to that of maize meal – 62 months and 43 months for price increases and decreases, respectively. With both variables, price increase observations are higher than those for price decreases are.

This time series from January 2000 until December 2017, has an equal account of drought and recovery period. However, price increase for both drought and recovery periods are more pronounced that price decreases. This supports the observations made in figure 5.1, that prices have been on an increasing trend over time and thus are expected to increase in the long run.

5.3 INFERENTIAL ANALYSIS

This section presents price transmission results for the white maize marketing chain when considering drought. Formal and informal preliminary tests are followed by causality and Error Correction Model results.

5.3.1 Graphical Analysis of stationarity

This section outlines the informal stationarity tests of all the variables used in the study, as shown in Figures 5.4 to 5.7.

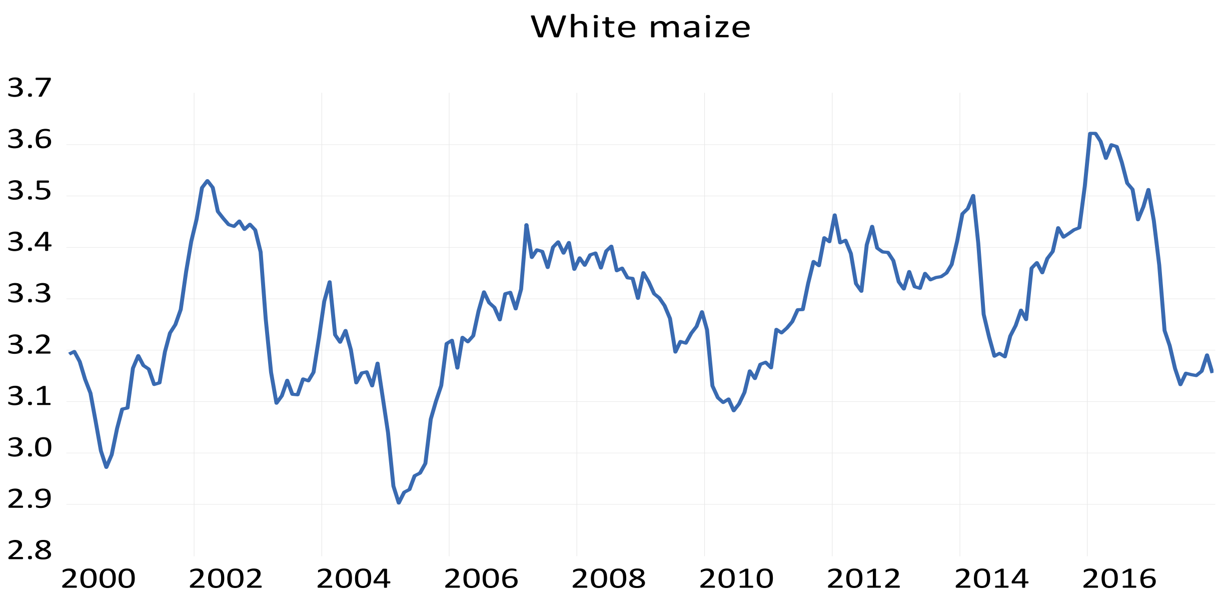

Figure 5.4: Graphical analysis of stationarity: Maize meal at level form

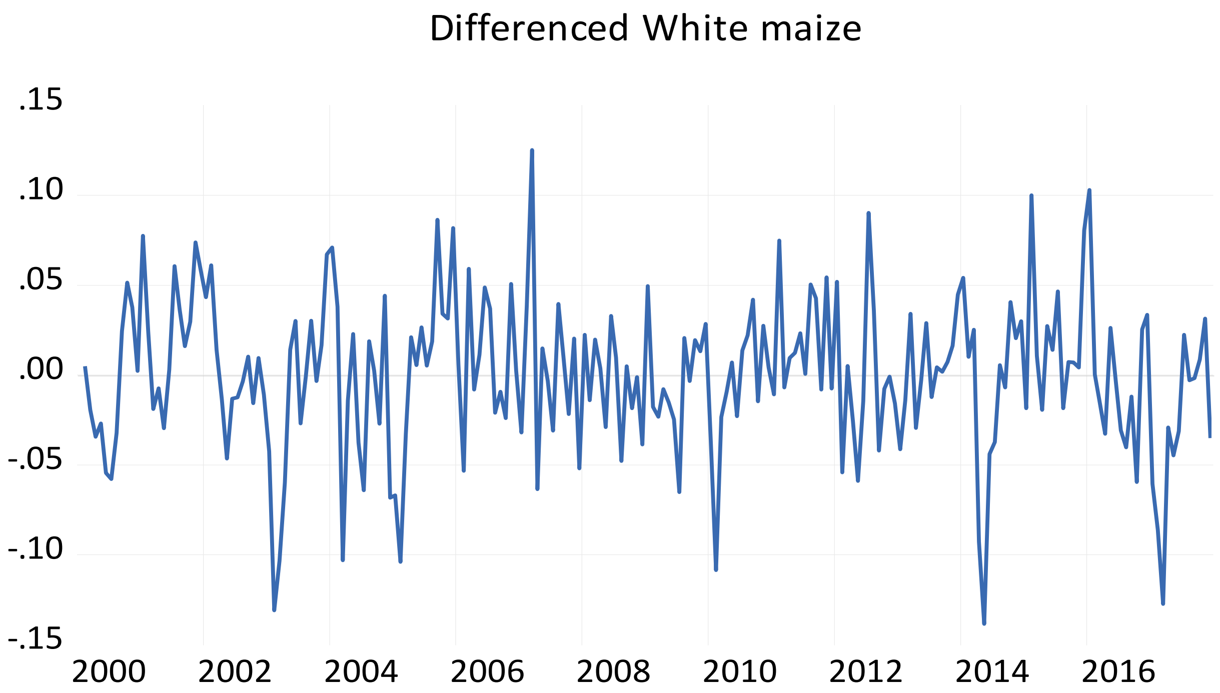

Figure 5.5: Graphical analysis of stationarity: Maize meal I(1)

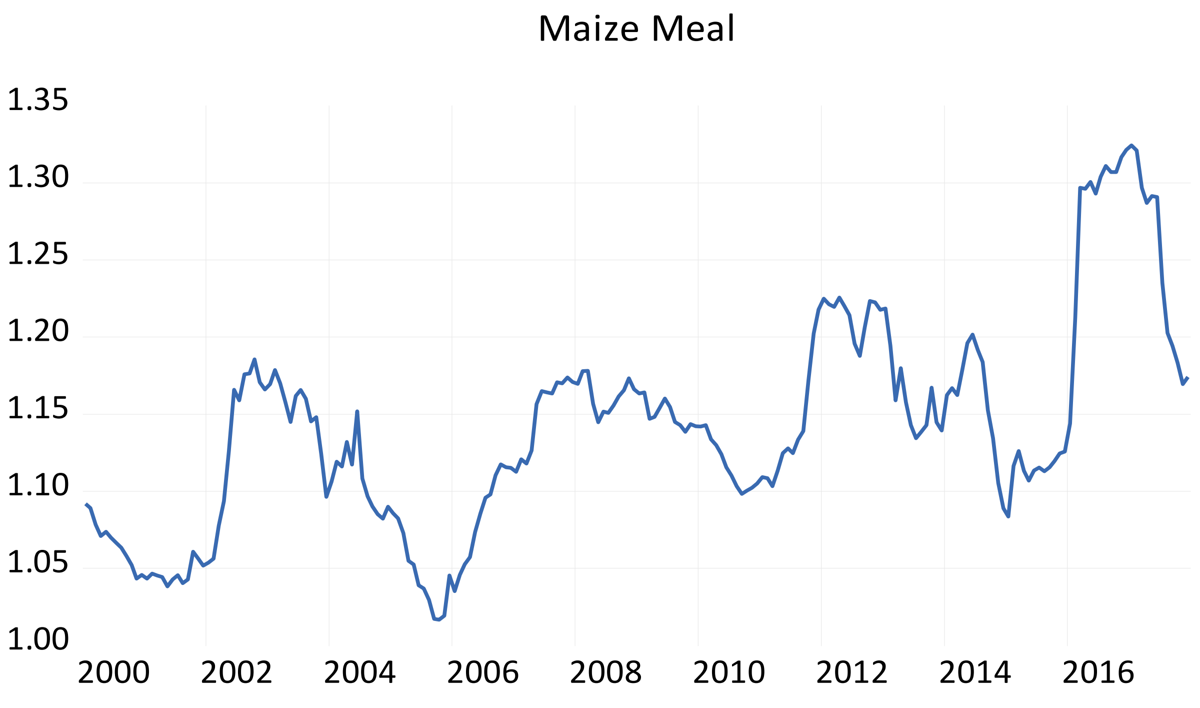

Figure 5.6: Graphical analysis of stationarity: White maize at level form

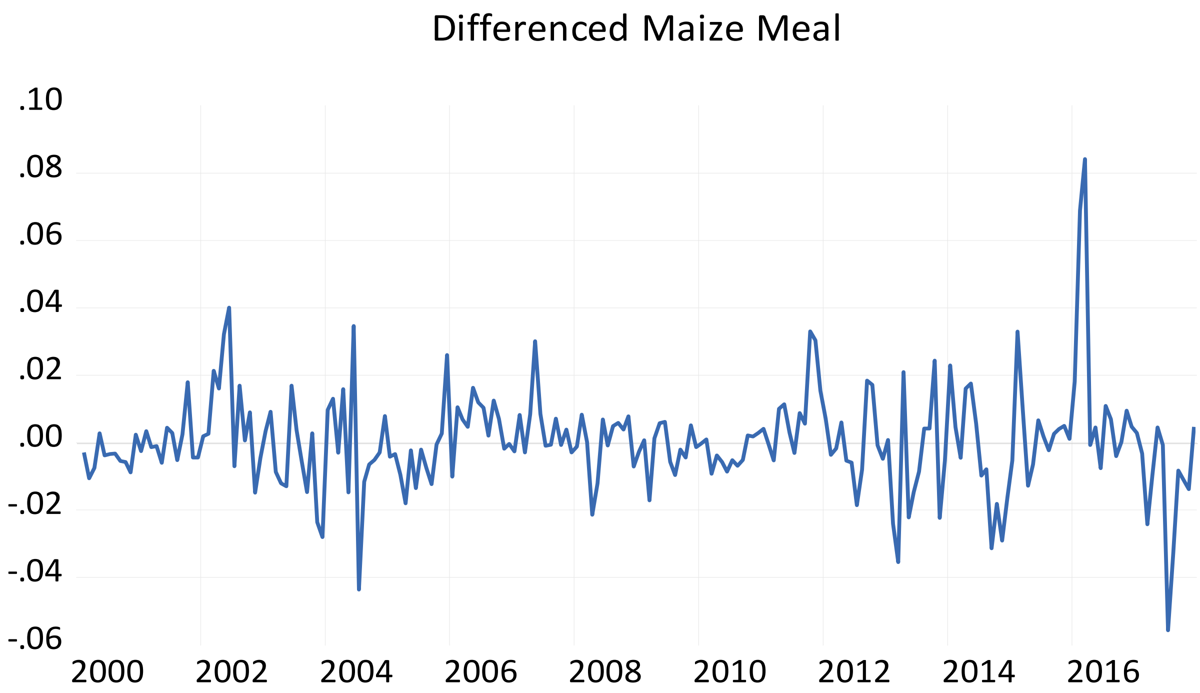

Figure 5.7: Graphical analysis of stationarity: White maize I(1)

All the variables in their level forms, over time, have been increasing and show an upward trend, time varying mean and variance. This is informal evidence that the observed variables are non-stationary. When differenced once, all observed variables are mean reverting, thus all the fluctuations are around the mean. This implies that the variables of the study are stationary when differenced once.

5.3.2 Statistical Analysis of stationarity

For the Error Correction Model to be valid, time series data need to be analysed for the presence of unit root. This subsection highlights the formal test of stationarity, as summarised in Table 5:2 and Table 5:3 below. Two tests were used, namely the Augmented Dickey Fuller and the Phillip Perron tests. If the observed $|\rho| = 1$, then a series has unit root, and stationary if the $|\rho| < 1$.

The results in Table 5:2 show unit root tests at level form. For the observed price variables at their level form, both the ADF and the PP test were not significant. This implies that at level form, none of the variables are non-stationary.

Table 5.2: Statistical analysis of stationarity with variables at level form

	τ, $\tau\mu$ and $\tau\tau$	**ADF**	**PP**
White Maize Price	No Trend &intercept τ	0.14	0.12
	Intercept τ_{μ}	-2.35	-2.32
	Trend and an intercept τ_{τ}	-3.04	-3.02
Maize meal Price 5kg	No Trend &intercept τ	0.72	0.13
	Intercept τ_{μ}	-2.34	-2.33
	Trend and an intercept τ_{τ}	-3.04	-3.02

**(**)[***] Statistical significance 10(5)[1]% level*

To avoid spurious regression, variables were transformed to I(1) to make them stationary. The unit root tests results are summarised in Table 5:3 below. Given that the τ, $\tau\mu$ and $\tau\tau$ values of the ADF and PP tests are more negative than the critical values are, we therefore reject the null hypothesis of non-stationarity. Therefore, it can be concluded that the variables in Table 5:3 are I(1), meaning that these variables are only stationary when differenced once, and will result in meaningful cointegration results. It can be concluded that the informal test results are consistent with formal test results. Since the variables are all stationary at I(1), the cointegration relationship can be estimated once it can also be proved that the residual of the regressed variables are also stationary. These findings are consistent with informal tests observed in subsection 5.3.1.

Table 5.3: Statistical analysis of stationarity with variables differenced once

	τ, $\tau\mu$ and $\tau\tau$	**ADF**	**PP**
D(White Maize Price)	No Trend &intercept τ	-10.61***	-10.64***
	Intercept τ_{μ}	-10.58***	-10.61***
	Trend and an intercept τ_{τ}	-10.57***	-10.61***
D(Maize meal Price2.5kg)	No Trend &intercept τ	-10.30***	-10.42***
	Intercept τ_{μ}	-10.29***	-10.40***
	Trend and an intercept τ_{τ}	-10.26***	-10.38***

**(**)[***] Statistical significance 10(5)[1]% level*

5.3.3 Causality tests

As shown in Figure 5.1, white maize and maize meal prices show a positive relationship. However, correlation does not imply causality. Causality reflects the direction of price flow, i.e. price movement is triggered from and moves from variable 1 to variable 2. A Granger causality test embedded in E-Views was used, with both variables being set at 2 lags. The results are summarised in Table 5.4 below.

Table 5.4: Granger causality results

1. Commodity – Retail prices (Sample Jan 2000 – Dec 2015)				
Null Hypothesis	**Lag(s)**	**Obs**	**F-Statistics**	**Probability**
WHITE_MAIZE does not Granger Cause MEALIE_MEAL2.5KG	2	214	13.27	0.00
2. Retail – Commodity Prices (Sample: Jan 2000- Dec 2015)				
MEALIE_MEAL2.5KG does not Granger Cause WHITE_MAIZE	2	214	0.09	0.92

Using the decision rule, we fail to reject the null hypothesis that white maize prices do not Granger Cause maize meal prices, at probability of 1%. However, we reject the null hypothesis which states that maize meal does not Granger Cause white maize.

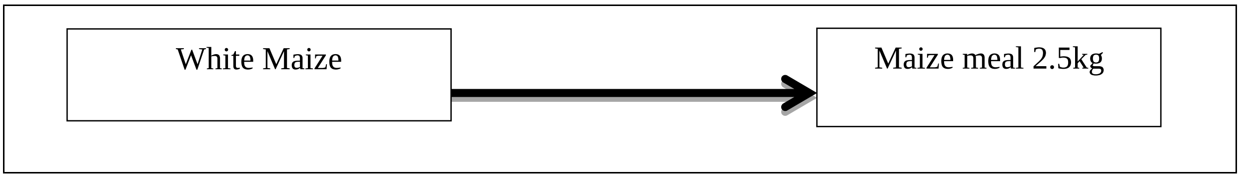

Figure 5.8: Direction of Price Flow

The causality results suggest that price flow is from white maize to maize meal prices, as shown in Figure 5.8 above. These results are essential in estimating long- and short-run equations. It implies that maize meal is to be regressed as a dependent variable of white maize in the co-integration and Error Correction Model.

5.3.4 Long-Run Relationship Analysis

This subsection presents the long-run regression results of the respective retail and commodity regression analyses, as summarised in Table 5.5 below. The author is unable to report on long-run relationships variables due to the sampling distribution of non-stationarity data which are non-standard, and thus asymptotic theory becomes violated. Lag length of -2 was chosen given significant results of the Akaike Information Criterion and the Schwarz Information criterion. Long-run regression was estimated to analyse the trend of their respective residuals.

Table 5.5: Long-run relationship analysis

Dependent Variable	Independent Variable	Coefficients
Maize Meal 2.5kg	White Maize(-2)	0.32***
	R^2	0.49
	Adj R^2	0.49

**(**)[***] Statistical significance 10(5)[1]% level*

To confirm the long-run relationship of the equation regressed in Table 5.5, the residual ought to be stationary. Two tests for stationarity were used, namely the Augmented Dickey Fuller and Phillips Perron tests.

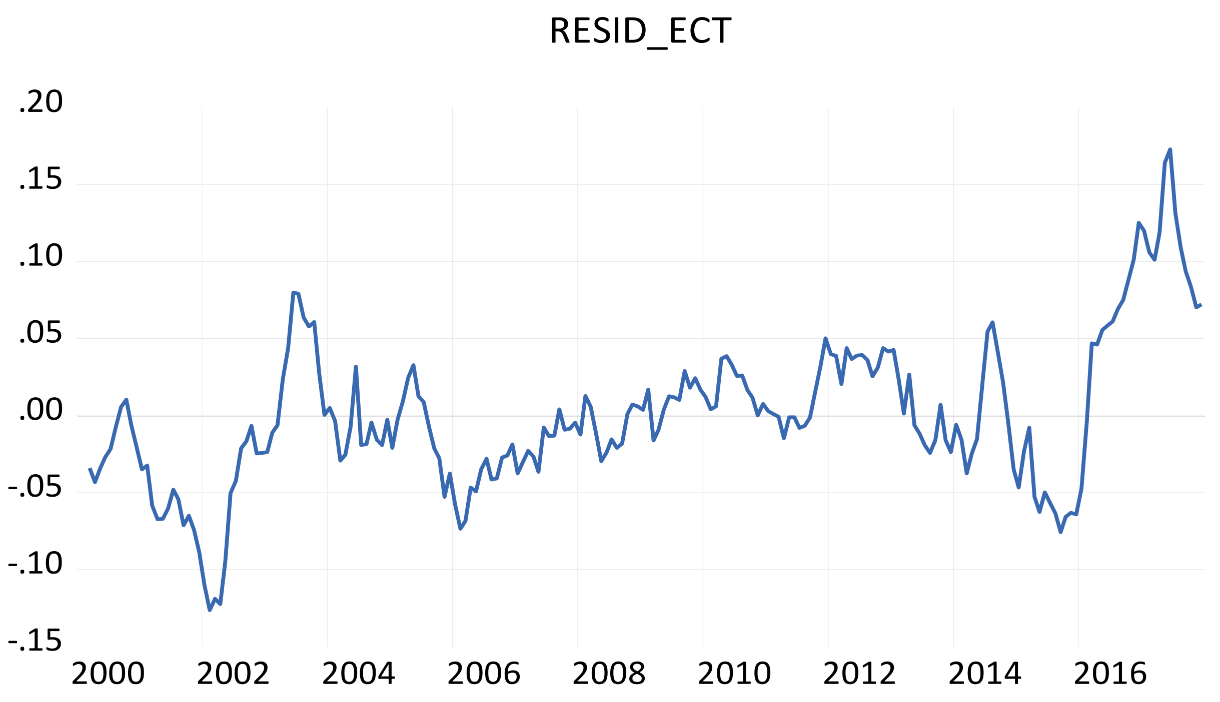

Table 5.6: Stationarity test of the long-run regression residuals results

	τ, τμ and ττ	**ADF**	**PP**
Maize Meal – Maize residual	No Trend &intercept τ	-2.93***	-2.74**
	Intercept τ_{μ}	-2.92**	-2.73*
	Trend and an intercept τ_{τ}	-3.50**	-3.33*

**(**)[***] Statistical significance 10(5)[1]% level*

Both tests were significant and confirm that the residuals are stationary. We can thus conclude that there is a long-run and equilibrium relationship between white maize and maize meal prices.

5.3.5 Short-Run Relationship Analysis

The residuals of the long-run relationship, as mentioned in the methodology section, are used as error correction terms in the estimation of short-run relationships. The results of the short-run relationship between farm and retail prices are summarised in Table 5.7 below. The goodness of fit of 0.16 indicates that approximately 16% of short-run variation in maize meal prices is explained in the model. According to Capps and Sherwell (2007), a low magnitude of R^2 may be largely attributed to the fact that the dependent variable corresponds to changes in the independent variable. Maize meal and maize prices have a positive relationship that is significant at a 5% level. This implies that any increase (decrease) in the white maize price is followed by an increase (decrease) in the meal prices. This is particularly true since the Granger causality shows that price information flows from farm to retail prices. The results presented in Table 5.7 allow a distinction to be made between price changes during a drought period. An ECT of -1 means that 100% of disequilibrium is corrected completely in the same time period to price changes in white maize. The estimation indicate that within a month maize meal prices adjust to eliminate approximately 16% and 9% of price increases and decreases during a drought period. Using a Wald test, a null hypothesis of symmetry was imposed. As shown in Table 5.7, we fail to reject the null hypothesis. Thus, there is no indication of asymmetry in price changes during a drought period. This is consistent with the descriptive analysis presented in Figure 5.3.

Table 5.7: Short-run relationship results for price changes during a drought period

	Dependent Variable	**Coefficients**
D(Maize Meal 2.5kg)	D(Maize(-2))	0.09***
	ECTD^{+}(-1)	-0.16**
	ECTD-(-1)	-0.09**
	H_0:ECTD+ = ECTD-	0.74
	R^2	0.16
	Adj R^2	0.15

**(**)[***] Statistical significance 10(5)[1]% level*

Table 5.8 below highlights results for price changes during a recovery period. ECTR+ statistically suggests that retail prices respond to deviations in the long-run equilibrium parity. Following a decline in white maize prices in the long run, only 5% of error is corrected per month during a drought period. However, ECTR- is not statistically different from zero, meaning that any cost savings triggered from white maize prices result in no significant changes in maize meal prices. A recovery period is characterised by a rapid decline in white maize prices, due to increased production volumes. However, these are not passed on to retail prices. Further, a Wald test confirms that ECTR- does not lead to any significant change in the retail maize meal prices.

Table 5.8: Short-run relationship results for price changes during recovery period

	Dependent Variable	Coefficients
D(Maize Meal 2.5kg)	D(Maize(-2))	0.10***
	ECTR+(-1)	-0.05*
	ECTR-(-1)	-0.05
	H0:ECTD+ = 0	3.26**
	H0:ECTD- = 0	0.27
	R^2	0.14
	Adj R^2	0.12

**(**)[***] Statistical significance 10(5)[1]% level*

The Error Correction Terms are all negative, showing that the system returns back to equilibrium, after being triggered by an external shock (Davids et al., 2016). Their *p*-values are significant, with the exception of the ECTR-, and according to Cutts and Kirsten (2006), this shows that maize meal prices do not react completely within one month to changes in white maize prices. The significance in the lag of the ECT may be due to the effects of wholesale prices, which are not captured in this study.

The magnitude of the error correction terms are small yet statistically significant. Consistent with the findings of Louw et al., (2017), error correction terms in the white maize marketing chain are corrected at a slow rate . Therefore, slow adjustment of the error terms suggests that the white maize market is weakly integrated. Noteworthy is that disequilibria is corrected faster during a drought period as compared to a recovery period. This may be an indication of absorbed inflation to encourage sales during a characterised by a hike in prices.

There is price symmetry in the white maize market due to the coefficients of the ECT being equal according to the Wald test. These findings are in line with those of Louw, Meyer, and Kirsten (2017).

It is worth considering that the response of retail prices to changes in farm prices is, in most cases, not instantaneous but is instead distributed over time. According to Kinnucan and Forker (1987), some of the reasons for delayed responses are;

- The food marketing industry functions with facilitation processes such as; storing, transportation and processing,
- There is a cost attached to re-pricing of products by retailers,
- The nature and sources of price data reporting and collection, and
- Imperfections in the market, such as market structure diversification, information asymmetry and assimilation.

However, these responses should be almost equal, regardless of the direction of price changes that are triggered from farm prices. Furthermore, the delay in price adjustment should not only be to the benefit of retailers, i.e. transmitting price increases completely and more rapidly than cost savings.

White maize price changes are transmitted faster during a drought period than a recovery period. Also, price decreases in white maize during a recovery period did not result in a change in maize meal prices. It can thus be concluded that retailers react more rapidly to price changes during a drought period. The results of this study suggest that variability in the South African rainfall levels contribute to the extended high maize meal prices during a recovery period in the white maize industry. Given the foregoing, maize meal prices react differently during a drought and recovery period

5.3.6 Residual diagnostic test

The diagnostic test was performed on the residual of the short-run regression output. This was done to assess whether any Classical Normal Linear Regression model assumptions were violated. A series of battery tests was done and the results are summarised in Table 5.9 and Table 5.10, below.

A Jarque Bera analysis was used to test whether residuals of the short-run model were normally distributed with a zero mean and a variance. Given *p*-values of 0.24 and 0.29, we fail to reject the null hypothesis that residuals are normally distributed.

A white heteroscedasticity test was used to test whether the variance of the residual terms were constant over different values of the explanatory variables. With *p*-value of 0.69 and 0.96, we fail to reject the null hypothesis of no heteroscedasticity.

A Breusch-Godfrey Serial Correlation LM Test was used to test whether the residuals were related to any observations. With *p*-values of 0.68 and 0.91, we fail to reject the hypothesis of no 2nd order serial correlation in residuals.

The last test for misspecification used the Ramsey Reset test to assess whether there was an inclusion of an irrelevant variable or an exclusion of a relevant variable. With *p*-values of 0.18 and 0.33, we fail to reject the null hypothesis of no misspecification.

Table 5.9: Battery test Results for price increases regression

Tests	**Tests statistic**	***p*-value**	**Conclusion**
Jarque-Bera (2)	2.83	0.24	Normally distributed
White Test(8)	5.63	0.69	No Heteroscedasticity
Breusch-Godfrey Serial Correlation LM Test(2)	0.78	0.68	No Serial Correlation
Ramsey RESET (3)	4.84	0.18	No Misspecification

Table 5.10 is explained above in relation to negative residual values.

Table 5.10: Battery test Results for price decreases regression

Tests	**Tests statistic**	***p*-value**	**Conclusion**
Jarque-Bera (2)	2.42	0.29	Normally distributed
White Test(8)	2.52	0.96	No Heteroscedasticity
Breusch-Godfrey Serial Correlation LM Test(2)	0.19	0.91	No Serial Correlation
Ramsey RESET (3)	2.21	0.33	No Misspecification

Based on the conclusion of the Battery Test, the short-run model does not violate the basic assumption of the Classical Normal Liner Regression.

5.4 APPLICATION OF THE RESULTS

The findings of this study are in line with the theoretical framework, as discussed in Chapter 3. The results suggest that rainfall levels in South Africa affects price formation along the white maize market. During a drought period, price changes are transmitted much quicker than during a recovery period; however, during a recovery period, cost savings are not transmitted to consumers. This implies that consumers are better off during a drought period than a recovery period, even though prices are expected to decline in the latter period.

To further illustrate this, the income levels of poor consumers and average maize meal prices were summarised and analysed, as indicated in Figure 5.9 below. Between 2006 and 2015, consumers spent lower shares of their income on maize meal during drought periods, as compared to the recovery periods. Poor consumers who fall within the FPL grouping spend approximately 0.6% more of their income to purchase maize meal during a recovery period, making them worse off than in a drought period. Those who fall within the LBPL and UBPL spend approximately 0.25% and 0.14% more, respectively, on maize meal during a recovery period.

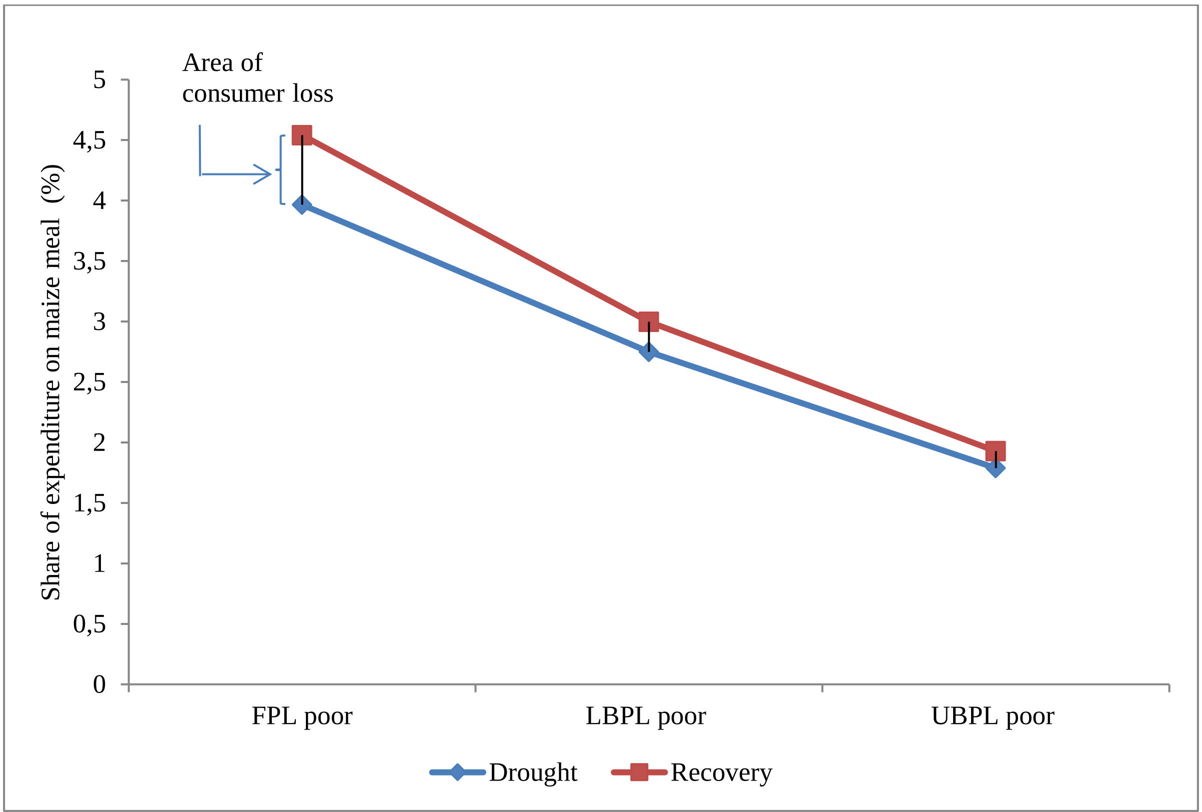

Figure 5.9: Average expenditure share on maize meal by South African poor consumers, 2006–2015

Source: StatsSA (2017) and author's calculations

The difference in the recovery and drought periods, as plotted in Figure 5.9 above, represents the area of consumer loss, as consumers spend a larger share of their incomes on maize meal during a recovery period. This difference and the percentage of expenditure share only takes account of bags of 2.5 kg maize meal. It is more likely that poor consumers purchase larger volumes of maize meal, i.e. 10 kg or 12.5 kg bags; therefore, the area of deadweight loss would be approximately four to five times larger for each poverty grouping when considering larger volumes of maize meal. It is noteworthy that, the poorer the consumers are, the higher their shares of expenditure on maize meal are, and the higher their values of deadweight losses are. Therefore, sustained price increases from drought results in consumer loss that is proportional to their income levels

5.5 SUMMARY

Chapter 5 of this study presents empirical findings that answer the research question of the study. The sub-objective of the study is to analyse price movements in the white maize and maize mean prices during the recovery and drought periods. The study found that for the study period, January 2000 to December 2017, maize meal prices were, on average, R12.24/2.5 kg, while white maize prices were, on average, R1 778.86/ton. Over the study period for both the variables, their highest values were in 2016, pointing to the severity of the 2015 drought period. It was also observed that short drought periods are followed by price increases in the recovery periods, while longer drought periods are followed by declines in the prices of white maize and maize meal prices.

The second sub-objective of the study is to examine price transmission along the white maize marketing chain for recovery and drought periods in the long and short runs. Firstly, variables were tested for stationarity using both formal and informal tests. Tests confirmed that both variables are non-stationary at level form. This implies that if they are regressed at their level form, they may reflect a false relationship. Variables show stationarity when differenced once. The results also show that price formation in the white maize market starts from the farm and is transmitted to retail prices. This was important to estimate so that when variables are regressed, the initial point of the price formation, in this case white maize, may be regressed as an independent variable against the last point of price, i.e. retail prices as dependent variables.

A long-run relationship between both variables was confirmed, as the error term was found to be stationary. Using the error terms of the long-run regression, error terms were segmented into ECTD+, ECTD-, ECTR+ and ECTR- to check for the presence of asymmetric price transmission in price changes during drought and recovery periods. Short-run regression results show that there is a short-run relation between both variables. Moreover, there is a positive relationship between white maize and maize meal prices, i.e. any increase (decrease) in one variable, leads to an increase (decrease) in another. The results suggest that price increases are transmitted faster from farm to retail prices during a drought period than they are in a recovery period. Cost savings from the farm were not statistically different from zero, and therefore they do not trigger any price changes in the retail sector during a recovery period.

Given that this study found the presence of symmetric price transmission in the white maize market and non responsiveness during a recovery period; the aim of the third sub-objective was evaluate the impact of drought on price formation in the white maize market for poor consumer's expenditure share. A descriptive statistics method was used and the study found that poor consumers spend a larger share of their income on maize meal during a recovery period than in a drought period. Poor South Africans (FPL, LBPL and UBPL) spend, on average, an income share of 0.33% more on purchasing maize meal during a recovery period. Furthermore, the poorer the consumer was, the higher the expenditure share on maize meal was.

The findings presented in this chapter highlight the fact that rainfall levels play a significant role in the price formation of the South African white maize market.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

The main objective of this study was to assess the effects of drought on price transmission along the South African white maize marketing chain. This was achieved through three sub-objectives. The first sub-objective was to analyse price movements in the white maize and maize meal prices during drought and recovery periods. The sub-objective was achieved by using descriptive statistics, and results were presented with the use of tables and graphs. The second sub-objective was to examine price transmission along the white maize marketing chain in drought and recovery periods in the long and short runs. The methodology utilised in achieving the sub-objectives was divided into two methods. The first method established a short-run cointegrating relationship between the variables. The second method estimated the degree of price transmission for recovery and drought periods in a short-run relationship. This was done by regressing differenced maize meal prices against differenced white maize prices for both drought and recovery periods. The last sub-objective was to determine the impact of drought on price formation in the white maize market given poor consumer's expenditure shares on maize meal. This sub-objective adopted an application of the Error Correction Model, and descriptive statistics analysis was used. This chapter now presents the conclusion, recommendations and policy implications, limitations, and possible areas for future research.

6.2 CONCLUSION OF THE STUDY

South Africa is a semi-arid to arid county with considerable fresh water resources. Since 2000, South Africa has gone through nine years where the annual average rainfall was below 600 mm. This study modelled any periods below 600 mm as drought periods, and those above as recovery periods. The implication of varying and below-annual average rainfall directly affects farmers and those who depend on agriculture for their livelihoods. Drought periods are characterised by increases in food prices, and the expectation is that during a recovery period, commodity and food prices would decline. Given that the demand for food is inelastic, an increase in food prices does not trigger a larger percentage change in the demand for food. Instead, consumers, especially poor consumers, would go without non-food items to purchase their original quantities of food items. Maize meal is an important staple food for South Africans, thus this study estimated price transmission behaviour of white maize changes to maize meal prices during recovery and drought periods.

To address the objectives of this study, monthly white maize and maize meal prices from January 2000 until December 2017 were used. Recovery and drought variables were generated by using a long-term annual average rainfall graph sourced from Weather SA (2018).

Descriptive statistics show that over the study period, white maize prices averaged at R1 778.89/ton and maize meal prices averaged at R12.24/2.5Kg. The highest values of both variables were observed during the most recent drought in 2015. This points out the severity of the 2015 drought. The findings of the study are based on white maize and maize meal price increases that were recorded over 60 months and 61 months, respectively. This is opposed to the drought price decreases, which were recorded over 47 months for white maize, and 44 months for maize meal prices. The same is also true for price changes during a recovery period. Price increases during a recovery period took place in more months than price decreases did periods. Granger causality results suggest that price formation in the white maize market starts from farm prices (white maize), going through to retail prices (maize meal).

The ADF and PP tests show that both the white maize and maize meal variables showed the presence of a unit root in level form. Once differenced, variables were stationary. Thus, any regression of these variables at I(1) will estimate meaningful results. The findings of this study suggest that there is a long-run equilibrium relationship between white maize and maize meal prices. This is because the residuals of the long-run regression were found to be stationary, even though the dependent and independent variables were not stationary at their level form.

To estimate the Error Correction Model, the residuals of the long-run relationship were decomposed into price increases and decreases for drought and recovery periods. A short-run regression was estimated with prices for maize meal and white maize differenced once. The results suggest that there is a positive relationship between the two variables. This implies that any price increase (decrease) in white maize is followed by price increase (decrease) in the maize meal price. The Error Correction Model results suggest that price increases during a drought are transmitted faster than price decreases. Price declines are transmitted faster during a drought period than during a recovery period. Retailers may be passing cost savings on to consumers during a drought period to encourage sales during a period characterised by rapid food inflation. Also, price symmetry is evident during this period. However, during a recovery period price decreases are not statistically different from zero, i.e. any cost savings during a recovery period are not transmitted to consumers.

As discussed in the theoretical framework, the fact that cost savings are not transmitted to maize meal prices during a recovery period (while price increases are transmitted) leaves consumers worse off. During a drought period, their purchasing power declined due to price increases. It is expected that during a recovery period, their purchasing power would increase due to decreased white maize prices. The difference in error correction terms and their general slow rate of transmission suggests the presence of non-competitive market power. Periods of absorbed inflation may be of benefit to the consumer, especially against a rising inflation rate. However, during a recovery period, consumers do not benefit from any cost saving that arises from a fall in producer prices. Poor consumers were found to spend a larger share of their income on maize meal during a recovery period than they did in a drought period. Moreover, the poorer the consumers are, the higher their expenditure shares on maize meal during a recovery period are. The findings of this study thus suggest that rainfall levels in South Africa are significant in explaining price transmission in the white maize industry.

6.3 RECOMMENDATION AND POLICY IMPLICATIONS

Maize is the most produced grain in South Africa, making it a staple food of the country. This is particularly true for the poor and the lower to middle income group earners, who comprise 63% of the South African adult population. Moreover, of the staples consumed in South Africa, maize meal is the lowest in price, proving it to be very important to South Africans.

This study showed that drought is a recurring phenomenon. Due to climate change, it has become more frequent in recent years. As has been established, recurring drought periods cause disruptions in price formation along a value chain. Although drought is an environmental phenomenon, policy analysts nevertheless need to consider its effects on the food security status of South African consumers, and more particular poor consumers. This study recommends that in any fiscal planning, especially for social welfare grant adjustments, consideration should be given to rainfall pattern projections before decisions are made. Furthermore, consideration should not only be limited to a drought period, but also be extended to post-drought periods. This is of importance, as this study found that during a recovery period, any cost savings from farm prices are not passed on to consumers, thus negatively affecting consumer welfare. To mitigate the effects of rising prices on the producer side of the value chain, investments can be made towards producing irrigated field crops to protect farmers against losses caused by variable rainfall patterns.

This research recommends that the possible non-competitive behaviour in the white maize market should be fully studied, understood and addressed. Furthermore, details of wholesaler prices should be made available for public consumption and analysis to allow interested persons to fully understand price formation transmission in the white maize market.

6.4 LIMITATIONS OF THE STUDY AND AREAS FOR FURTHER RESEARCH

The limitation of this study is the unavailability of details of white maize and maize meal prices at wholesale level. The availability of such data would enable researchers and policy makers to understand the accurate direction of price flows and price transmission behaviour along the white maize marketing chain.

The study only analysed the situation regarding 2.5 kg bags of maize meal, given that this data was available for the study period. The majority of poor South African households purchase 10kg and/or 12.5kg bags of maize meal. Nevertheless, the results of the study can be multiplied by 4 to 5 times to understand the extent to which poor consumers' income shares change during drought and recovery periods.

In further studies, a rainfall index could be used to incorporate the effects of the El Nino and LA Nina weather phenomena on price transmission at different regimes. This study made use dummy variables to differentiate drought from recovery periods, which approach does not highlight the extent of a drought as influenced by El Nino or La Nina over the years.

Given that consumers purchase different food items, other than maize meal, future studies could also estimate the effect of drought on asymmetric price transmission of other food items.

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APPENDICES

Appendix A

Types of asymmetry

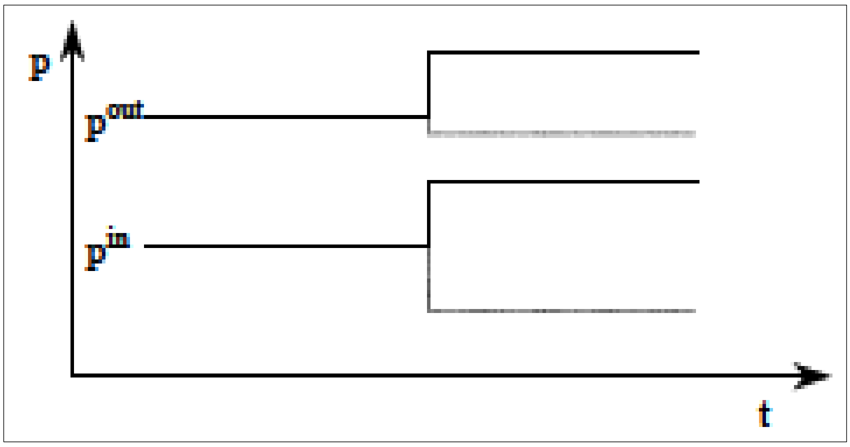

Figure 8.1: Magnitude: Price transmission

Source: Meyer and von Cramon-Taubadel (2002),

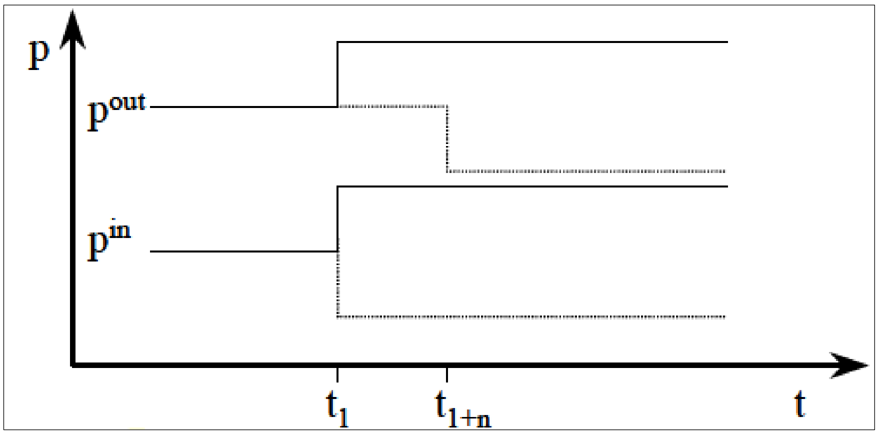

Figure 8.2: Speed: Price Transmission

Source: Meyer and von Cramon-Taubadel (2002)

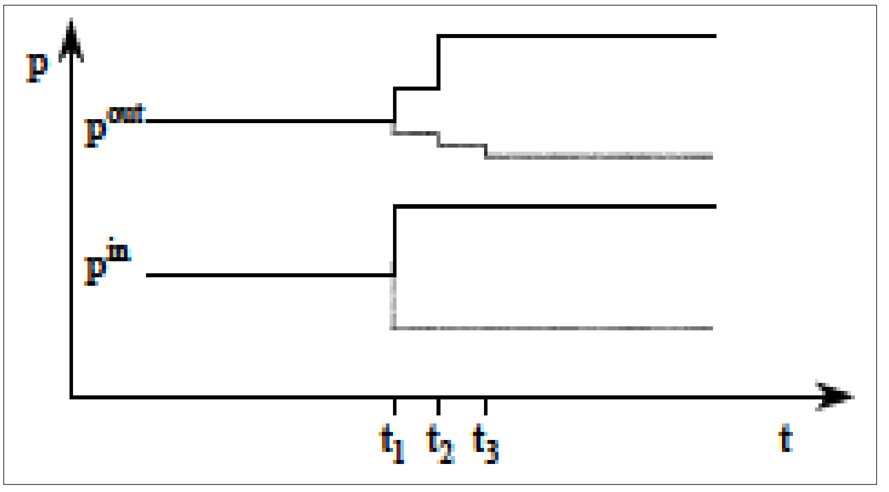

Figure 8.3: A combination of magnitude and speed asymmetric price transmission

Source: Meyer and von Cramon-Taubadel (2002)

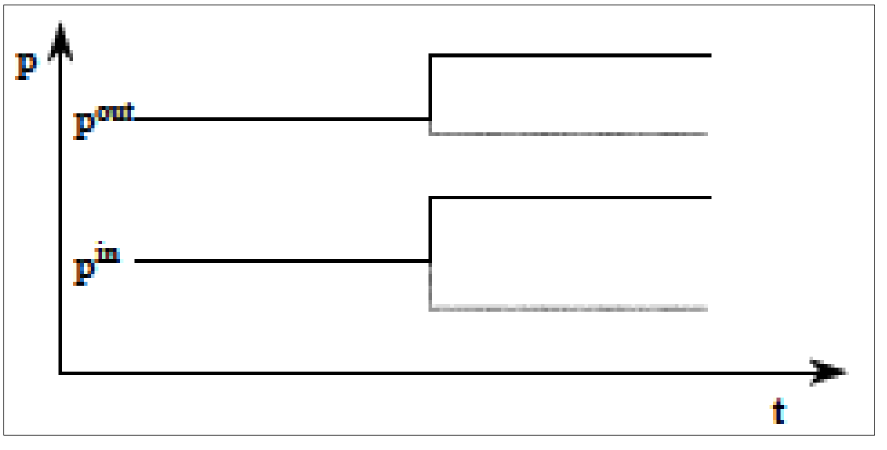

Figure 8.4: Positive asymmetric price transmission

Source: Meyer and von Cramon-Taubadel (2002)

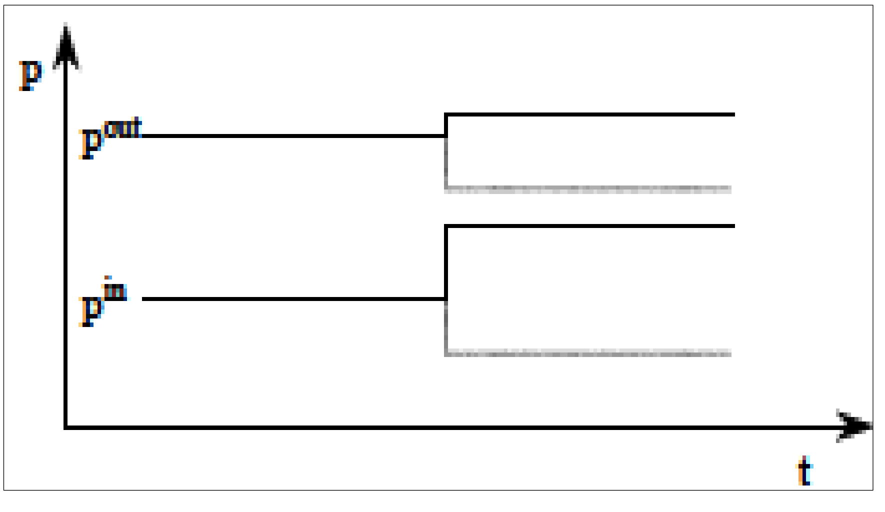

Figure 8.5: Negative asymmetric price transmission

Source: Meyer and von Cramon-Taubadel (2002)

Appendix B

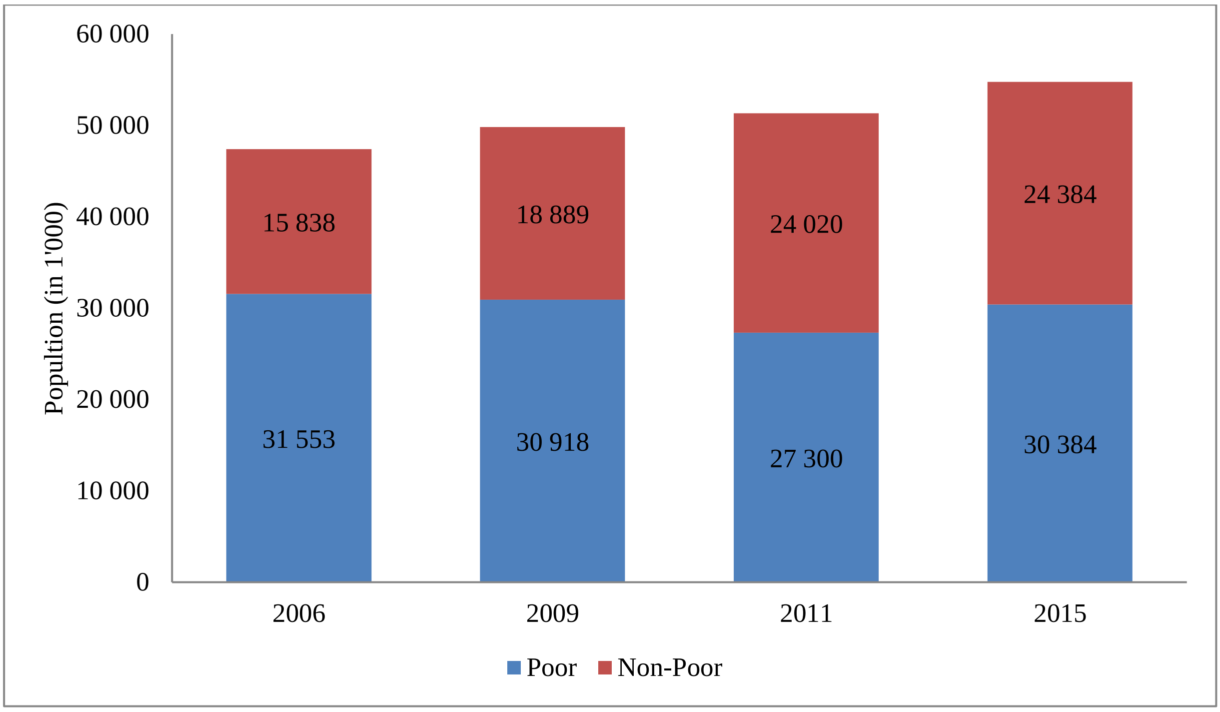

Figure 8.6: Poor and non-poor South Africans

Source: StatsSA (2017)

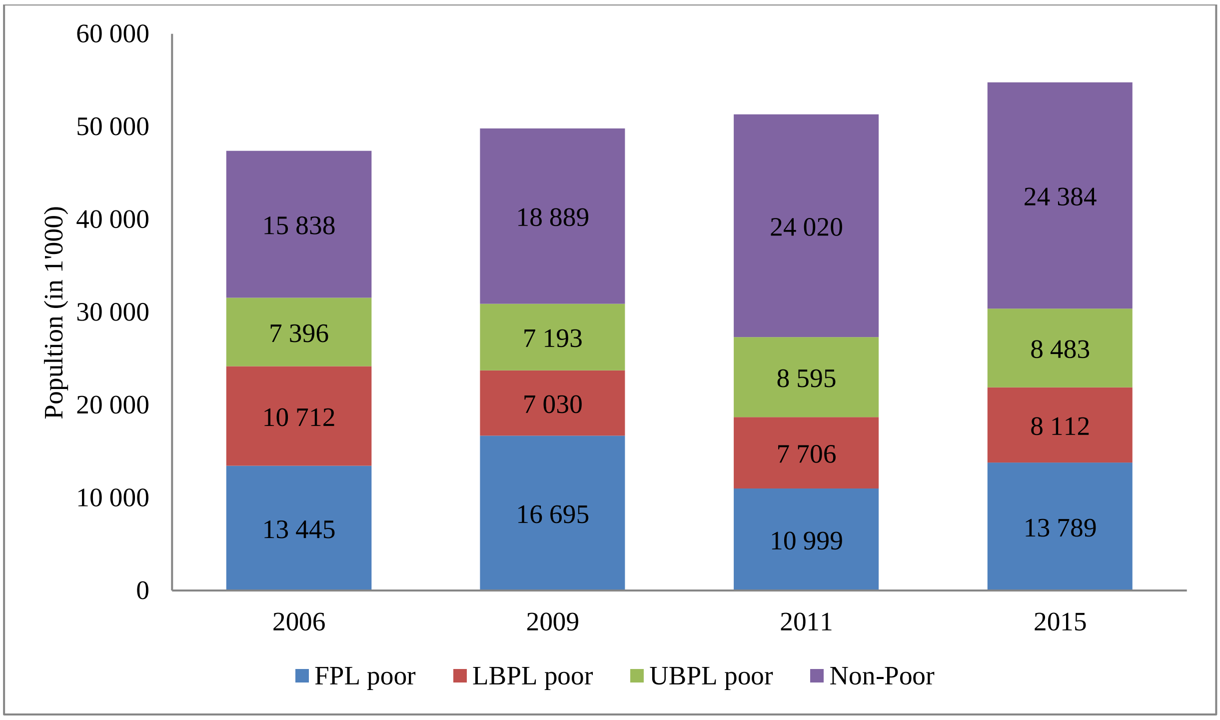

Figure 8.7: Category of poor persons in South Africa

Source: StatsSA (2017)

Table 8.1: Rand values of annual average maize meal prices and Income levels PPPM for a poverty group

	Maize Meal	FPL	LBPL	UBPL
	R/2.5kg	Average income PPPM (Rand)		
2006	12,15	219	370	575
2007	14,18	327	396	613
2008	14,55	274	447	682
2009	14,14	318	456	709
2010	13,11	320	466	733
2011	13,84	335	501	779
2012	16,41	366	541	834
2013	14,48	386	572	883
2014	14,51	417	613	942
2015	13,02	441	647	992

Source: StatsSA (2015), StatsSA (2017)
**shaded area represents years of drought*

Appendix C

Table 8.2: Long-Run Regression Output

Dependent Variable: MAIZE_MEAL(-2)
Method: Least Squares
Date: 12/12/18 Time: 23:04
Sample (adjusted): 2000M03 2017M12
Included observations: 214 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WHITE_MAIZE(-2)	0.320076	0.022527	14.20844	0.0000
C	0.090824	0.074025	1.226934	0.2212

R-squared	0.487774	Mean dependent var	1.141528
Adjusted R-squared	0.485358	S.D. dependent var	0.068149
S.E. of regression	0.048889	Akaike info criterion	-3.189227
Sum squared resid	0.506708	Schwarz criterion	-3.157770
Log likelihood	343.2473	Hannan-Quinn criter.	-3.176515
F-statistic	201.8797	Durbin-Watson stat	0.114025
Prob(F-statistic)	0.000000		

Table 8.3: Short-Run Regression Output – Drought

Dependent Variable: D(MAIZE_MEAL)
Method: Least Squares
Date: 12/13/18 Time: 12:30
Sample (adjusted): 2000M04 2017M12
Included observations: 213 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(WHITE_MAIZE(-2))	0.088366	0.024226	3.647551	0.0003
DP(-1)	-0.158977	0.065831	-2.414910	0.0166
DM(-1)	-0.090133	0.040314	-2.235806	0.0264
C	0.000350	0.001108	0.316287	0.7521

R-squared	0.162505	Mean dependent var	0.000449
Adjusted R-squared	0.150484	S.D. dependent var	0.015033
S.E. of regression	0.013856	Akaike info criterion	-5.701608
Sum squared resid	0.040125	Schwarz criterion	-5.638485
Log likelihood	611.2213	Hannan-Quinn criter.	-5.676098
F-statistic	13.51791	Durbin-Watson stat	1.467888
Prob(F-statistic)	0.000000		

Table 8.4: Short-Run Regression Output – Recovery

Dependent Variable: D(MAIZE_MEAL)
Method: Least Squares
Date: 12/13/18 Time: 12:31
Sample (adjusted): 2000M04 2017M12
Included observations: 213 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(WHITE_MAIZE(-2))	0.102603	0.024073	4.262215	0.0000
RP(-1)	-0.048629	0.026929	-1.805859	0.0724
RM(-1)	-0.047126	0.043217	-1.090441	0.2768
C	0.000738	0.001184	0.623421	0.5337

R-squared	0.136867	Mean dependent var	0.000449
Adjusted R-squared	0.124477	S.D. dependent var	0.015033
S.E. of regression	0.014066	Akaike info criterion	-5.671454
Sum squared resid	0.041354	Schwarz criterion	-5.608331
Log likelihood	608.0099	Hannan-Quinn criter.	-5.645944
F-statistic	11.04701	Durbin-Watson stat	1.457830
Prob(F-statistic)	0.000001		