Measuring spatial market integration between urban and rural food markets in South Africa

By

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DECLARATION

I, <u>Sydwell Maletjile Lekgau</u> declare that this dissertation is my own original work and is submitted for the degree MSc in Agricultural Economics at the University of Pretoria. The dissertation has not been submitted for any examinations or for any degree at any other University. The sources used in writing of this dissertation have been acknowledged through a complete list of references. I am aware of the university policy and implications regarding plagiarism.

Signature:_____

Date:_____

DEDICATION

I dedicate this dissertation to the almighty God, Jehovah-Shammah, the creator of heaven and earth. He is sitting on the highest throne in heaven, with Jesus on his right hand side and is praying and pleading for us daily. He is watching us day and night to see if we still please him. If it was not by His mighty power, works and grace, I could have not completed this research work. He deserves to be praised, for He is worthy, He is holy, and glory unto him alone. He cannot be seen with human eyes but I did see Him helping me from the start of my studies at University of Pretoria until the end. To God is the glory, amen and amen.

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ABSTRACT

This study focused on measuring spatial market integration between urban and rural food markets in South Africa. The study was influenced by continual debate on the issue of high food price increases among the basic agricultural foods which have impact on food price differentials that exists in market locations. Higher food price differentials between market locations can have negative implications for households' livelihoods. In South Africa the majority of lower-income earners live in rural areas, which implies that the disposable incomes of those households are affected differently by higher price differentials. To ensure that there are lower price differentials between market locations, spatial market integration is required.

The main objective of this study was to measure spatial market integration between urban and rural food markets. This objective was achieved through the modelling of secondary price data of the 2.5 kg package of super maize meal. Data used in the study was collected by the NAMC and Stats SA during the

period of November 2006 to July 2012. The study used a co-integration model, together with the Vector Error Correction Model (VECM) and the Autoregressive Distributive Lag (ADL) model.

The study revealed that out of the nine markets which were measured for spatial integration, six of the rural food markets were co-integrated with urban markets. Estimation of the six co-integrated markets with the VECM revealed a long-run equilibrium relationship between urban and rural food markets. The VECM results further showed different speeds of price adjustments to the long-run equilibrium which was faster (65% on average) in five markets and slower (40 %) in one market. The fast speed of price adjustment to long-run equilibrium relationships suggests that transaction costs have significant effects on markets linkages. Markets also showed different time of adjustments which was between three and five months. Short-run dynamic effects were found in only three markets and could not be established in the other six rural food markets. Price information flow, transportation costs and transaction costs are seen as bottlenecks that prohibit integration of markets in the short run. With regard to price relationships, the study found statistically significant differences between urban and all rural food market mean prices. This suggested that the price of 2.5 kg maize meal was generally high in all rural markets, as compared with urban markets. Markets with very high price increases were those located in the lower production potential areas of the maize commodity.

The Impulse Response Function (IRF) was employed to establish the effects of negative and positive price transmission shocks from the urban to the rural food markets. One standard deviation was put into the model to establish the response of markets to shocks. The markets tested revealed a period of between two and eleven months for the negative and positive impulses to be cleared in all the markets. A high degree of spatial market integration was found when negative and positive shocks did not exhibit price diversion from the long-run equilibrium relationship.

Key words: Food prices, Market integration, Vector Error Correction Model (VECM) and Autoregressive Distributed Lag (ADL) Model.

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LIST OF ACRONYMS/ABBREVIATIONS

ADF	Augmented Dickey Fuller
ADL	Autoregressive Distributed Lag
AIC	Akaike Information Criterion
AR	Autoregressive
ARCH	Autoregressive Conditional Heteroskedasticity
CEC	Crop Estimate Committee
CV	Coefficient of Variation
DAFF	Department of Agriculture Forestry and Fisheries
DF	Dickey Fuller
EC	Eastern Cape
FAO	Food and Agricultural Organisation
FPM	Food Price Monitoring
FS	Free State
GP	Gauteng Province
GVP	Gross Value of Production
JSE	Johannesburg Stock Exchange
KZN	KwaZulu-Natal province
LM	Local Municipality
LOP	Law of One Price
LP	Limpopo province
MP	Mpumalanga Province
NAMC	National Agricultural Marketing Council
NCP	Northern Cape Province
NFPM	National Fresh Produce Markets
NW	Northwest Province
SA	South Africa
SAFEX	South African Future Exchange
Stats SA	Statistics South Africa South Africa
TVECM	Threshold Vector Error Correction Model
VECM	Vector Error Correction Model
WC	Western Cape

CHAPTER 1: INTRODUCTION OF THE STUDY

1.1   Background

High food price increases is one of the important topical issues in South Africa. This is mainly because high food price increases have impact on price differentials that exist between market locations. Higher food price differentials have negative implications for livelihoods, irrespective of urban, peri-urban or rural location. In South Africa the majority of lower-income earners live in rural areas (National Agricultural Marketing Council, 2010). This implies that the disposable incomes of households are affected differently by increases in food prices which can be seen through higher price differentials. Although household incomes are affected differently, many people living in rural areas, due to their lower income status, might not afford basic agricultural products when there are higher food price increases.

The important question with respect to higher food prices differentials between urban and rural markets if it exists is whether the price increases or decreases are transmitted smoothly across spatially in order to ensure food affordability by consumers in different market locations. For example since late 2006, South Africa experienced rising food prices of basic products, including maize meal. The increases in price were even worse during 2007 and 2008 when the world experienced the food crisis. SA was not immune to the food crisis and the price of maize increased significantly. The world food price has continued to increase again in 2010 and was even higher than the 2008 prices (Abidoye & Labuschagne, 2014). This clearly shows that international prices were transmitted to domestic prices. With this situation, it can be said that South African commodity markets are integrated with the international markets.

Markets are integrated when there is co-movement of prices across spatially separated markets (Goletti, Ahmed & Farid, 1995). This means agricultural product prices move together in a similar pattern. The study of market integration can better be understood within the context of the Law of one Price (LOP). Kohls and Uhl (1988) define LOP as a condition in which prices in the

markets are uniform after taking into account time, form and cost of adding a price in the market. This implies that, under competitive market conditions, all identical products should have the same price, differing only in transaction costs. However, due to different transactional costs and transfer costs between market locations, price of the products differs. Price differentials attract and create incentives for market agents and/or market actors to engage in exchange (Rashid, Minot, Lemma & Behute, 2010). In a free market, the fundamental cause of price differences between market locations can be attributed to distance between the markets, and the transfer and transaction costs involved in the distribution of goods. Price differentials are, therefore, not a serious concern, but price differentials between markets that cannot be explained by transportation costs and distance should raise concerns as this could suggest lack of market integration. Excessively higher price differentials between food markets, for example, can further suggest that households with lower income are vulnerable to food insecurity.

Price is paramount and central to the functioning of markets and it can provide an indication as to whether markets are integrated. Higher food price differentials among basic agricultural products, such as maize meal, are a concern for development. Important to this study is to establish whether there is a price transmission between urban and rural food markets and/or whether markets are integrated. This implies determining whether price transmission exists when food prices increases and decreases overtime. If price transmission occurs between the markets, it means that markets are integrated and this can ensure that food is affordable.

According to Goodwin and Schroeder (1991), if price changes in one market are consistently shown in another market, such markets can be regarded as integrated. When markets are integrated, it can be argued that there is a smooth price transmission process and that the price determination process, which occurs through the interaction of demand and supply, is functioning effectively. On the other hand, when markets are not spatially integrated, price signals will not be transmitted spatially and the effect of policy intervention in one market cannot affect the other markets. As a consequence, markets that

are not integrated operate differently from others and prices in those markets might turn out to be higher, compared with integrated markets where prices move together.

If differential pricing is small or does not exist between markets, this might be associated with some policy intervention, such as pan-territorial pricing, which existed during the 1970s and 1980s (Rashid *et al.*, 2010). Pan-territorial prices resulted in cross-subsidisation of producers, who were located far away from the main markets, by those producers who were located nearer the markets owing to prices which were fixed and this resulted in spatial dispersion of production (Vink, 2011). Through market integration, prices are determined by market forces of demand and supply and a consistent, smooth price transmission occurs between the markets.

According to Delgado (1986), a regional balance between food deficit and surplus regions occurs when agricultural markets are integrated. When markets are integrated, prices fluctuate less and a high price in deficit regions will lead to the flow of goods from surplus to deficit regions. This creates arbitrage opportunities for market actors to engage in trade. Without spatial market integration, price transmission will not occur between markets and there will be no movement of products between the regions. Volatility of prices will arise and producers will find it difficult to specialise to their long-term comparative advantage (Baulch, 1997:477). Market integration is needed for better planning by the market actors and is further important to ensure food is affordable among the consumers in different market locations as price signals will be transmitted between the markets thereby ensuring that there are no higher price differentials.

According to the NAMC (2003), food prices in rural food chain markets are generally higher than in urban centres and rural households experience food prices and food price inflation differently from urban households. This can be attributed to the fact that urban food markets are located in the city centres where there is good infrastructure and flow of information between groups of markets, as compared to spatial rural food markets. Within this context, it is

assumed that some urban food markets are integrated. Kirimi, Sitko, Jayne, Karin, Muyanga, Sheahan, Flock and Bor (2011) pointed out two important questions that relate to commodity pricing, that is, how to keep farm prices high enough to provide production incentives for farmers while at the same time keeping them low enough to ensure the consumers have access to food. The second question is how to effectively deal with food price instability, which is frequently identified as a major impediment to small-scale productivity and food security.

Understanding spatial market integration and the price transmission process is important for identifying market inefficiencies in South African markets. Knowledge of market integration is, therefore, important for the designing of appropriate policies and interventions that would assist in the better functioning of markets. This should further ensure that price problems and other related factors are addressed in the regions where market integration does not exist. The overall objective of this study is to determine if markets are integrated, thereby providing facts as to how markets relate with each other.

This chapter is organised as follows: section 1.2 describes the problem statement, section 1.3 states the research questions, and the objectives and hypothesis of the study are provided in section 1.4 and 1.5. The purpose statement is provided in section 1.6. Section 1.7 gives the academic value and the contribution of the study. The chapter ends with the delimitations of the study in section 1.8, given the availability of price information for the study.

1.2   Problem statement

Price differentials are the base for markets existence. Price differentials can be attributed to the distances between market locations, with transfer and transaction costs being the largest contributors, assuming that perfect market information exists. However, excessive higher food price differentials between market locations on the basic agricultural products constitute a major problem. This raise two questions, firstly as to whether poor households will afford basic agricultural products and secondly as to whether markets are integrated or not.

Establishing whether markets are integrated is important to determine how rural households are exposed when there is increasing food prices from urban to rural food markets. Higher price differentials between market locations might point to a lack of market integration. When markets are poorly integrated, products become expensive and households with lower incomes can become vulnerable to food insecurity, and some might not even afford basic agricultural foods.

There are many factors that can cause lack of market integration between rural and urban markets, namely non-competitive behaviour or imperfect competition between markets, non-competitive transport operation systems, non-transparent market information systems, dissimilarity between production regions, location of major suppliers, marketing infrastructure (storage capacities and processing facilities), and lack of public infrastructure (e.g. tarred roads). Other important factors that can lead to poor integration include government restrictions on trade and policies affecting the price transmission process. Striking the balance between these factors is a serious challenge for development and such a balance is required for markets to integrate.

Markets might not integrate because of imperfect competition between the different transport operators. For example, excessive transportation costs between two markets might mean higher price differentials, but if other markets do not experience a similar situation this might suggest a problem of public infrastructure or lack of competition between transport operators. Therefore, this could suggest that policy directives should focus on improving the road infrastructure or improving competition among the transport operators.

Markets might also not integrate because of inefficient flows of market information. According to Effiong and Ayawari (2005), for efficient marketing purposes, comprehensive details of economic information covering prices and the supply and demand situations in different markets should be available to producers, middlemen and consumers, alike, at various stages of the marketing channel. These will reduce the business risks, the costs of transactions and will allow market actors to explore trade opportunities which are beneficial

(Robbins, 2000). A lack of market information between urban and rural food markets might lead to a higher marketing margin in one market and less in another. This might indicate a lack of market integration and the focus will then be to improve market information systems.

Non-competitive behaviour, such as carried out by monopolies, can lead to excessively higher price differentials between markets. This behaviour might be caused by distances between markets and shortages of agricultural products in regions. However, if markets are integrated there should not be excessive price differentials and price increases will be spread across different market locations. The theory of demand and supply states that prices tend to be high when there is scarcity and low when there is surplus. The problem is in regions where there is a very high price for basic agricultural products, such as maize meal, bread, sugar, tea and vegetables, and households living in those regions may be seriously affected and their standard of living may deteriorate. Disintegration of markets leads to poverty and food insecurity.

High price increases in agricultural products present a further problem for households in that, when food price increase, markets agents will instantly pass the increases on to the consumers. This means that if markets are not integrated, the food price increases will be felt more in non-integrated regions. Hence, poor households will be forced to allocate more of their income expenditures to food (Altman, Hart & Jacobs, 2009). It is therefore important to ensure that investigation is made between rural and urban food markets to determine if markets are integrated.

According to Von Braun (2008), the rising trend of food prices has raised major concerns about food and the food situation in the world, particularly in developing countries. When prices of food continue to increase, many industrialised countries, through their governments, intervene by providing protective measures against the high food prices. A food aid voucher is an example of intervention measures used by industrialised countries. However, most of the protective measures are for the short term, indicating that countries affected will still face problems in the long run. The study of spatial market

integration makes it possible to identify markets that are integrated so that appropriate long-lasting interventions are designed for non-integrated markets and further to improve markets that are poorly integrated.

1.3 Research questions

The research questions examined in this study are as follows:

- Is there a significant price difference between urban and rural food markets in South Africa?

- Are the urban and rural foods markets in South Africa integrated or segregated?

- What is the time periods taken for positive and negative shocks to be eliminated from the market?

- How long does it takes for food markets to return to equilibrium after deviations have occurred?

1.4 Research objectives

The overall objective of this research study is to measure spatial market integration between urban and rural food markets in South Africa. The study is guided by the following specific research objectives:

- To establish if price transmission takes place between urban and rural food markets;

- To analyse the price spread between urban and rural markets, including price variability;

- To determine how spatial markets respond to price shocks; and

- To determine the time it takes for spatial markets to return to equilibrium after deviations had occurred.

1.5 Hypothesis

The study aims to test the following hypothesis:

- Spatial price transmission takes place between urban and rural food markets. Price transmission is expected to move from urban to rural food markets and not vice versa;

- There are no higher price differentials in rural markets compared to urban markets, including price variability;

- Rural markets will respond faster when there are negative and positive price shocks in the urban food markets and

- It will take a short period of time for spatial markets to return to equilibrium.

1.6 Purpose statement

Market integration is important for the development of many developing countries and it continues to be important in the formulation of agricultural policies (Lohano & Mari, 2005). Within this development context, market integration serves as a precondition for effective rural development, thus shifting from centrally-developed towns to under-developed rural areas. When markets are integrated, producers tend to specialise in the production of commodities in which they have a comparative advantage and where more benefits are derived through economies of scale (Vollrath, 2003). On the hand, consumers will also benefit from paying affordable prices when markets are spatially integrated. Understanding the degree of market integration and the transaction costs involved between groups of markets is important for identifying problems in agricultural food markets.

Many studies of food market integration have concentrated on price transmission along the value chain, for example the study by Vavra and Goodwin (2005), and less on spatial/horizontal price transmission. The main objective of this study is to measure horizontal price transmission between urban and rural food markets in South Africa with respect to the trade in maize meal product. As prices increase or decrease in particular regions, households

are directly affected as consumers of food. The intention of this study is to establish whether markets are integrated and to understand the degree of market integration as prices change over time between market locations and to investigate problems of integration, if they exist.

According to Sen (1981), most food crises in the world come from distribution and entitlement problems, rather than from food and its availability. A deeper understanding of spatial market integration is important, as it will help in the designing of appropriate policy measures required to address the problem relating to food distribution between market locations. Studying market integration processes is important because if geographically separated markets are well integrated, then efforts made by government to improve food security through policy design and implementation will be reduced or shifted to regions/provinces where it is mostly needed.

Rural food chain stores play an important role in the South African economy, so it is very important to know if price transmission exists between urban and rural food market locations. Currently, little is known about price differentials between urban and rural food markets. It is further not known whether markets are integrated or not. Therefore, it is important to investigate whether urban and rural food markets are integrated and to understand their relations, if they exist. This will assist in order to design appropriate policy measures that will improve the relationship between the markets and to address the problem of segregation, if it exists.

1.7   Academic value and contribution of the study

This research builds on a request which was made by the South African Cabinet to establish a permanent Food Price Monitoring (FPM) system in South Africa. The establishment of FPM came about as a result of the high food prices which were experienced in 2002. For continued price monitoring, the NAMC publishes a quarterly food price monitor which provides information on price trends. The quarterly food price report concentrates on the percentage increases or decreases in the prices of basic food. The report does not inform

policy makers on market integrated-related aspects. Having identified this gap, the purpose of this research is to deepen the understanding of spatial market integration, given the differential pricing of food which exists in distinct market locations, in this case, the urban and rural food markets. Therefore, this study intends to fill the information gap that currently exists and at the same time to contribute to the academic value of research on spatial price relationships.

Many studies conducted on price transmission have concentrated on analysing vertical price transmission, for example the study by Vavra and Goodwin (2005) studied price transmission along the value chain. A study on vertical price transmission does not provide an indication of how markets relate to each other. This research focuses on horizontal price transmission and it will include both urban and rural food markets relationships. Important to this study is the fact that the literature review on spatial market integration revealed no studies made on spatial market integration that included urban and rural food markets in South Africa. The inclusion of a rural food price analysis within the context of spatial market integration will offer valuable contributions to academic research and to policy making.

1.8 Delimitations

This study has several delimitations. Firstly, the study focuses on measuring spatial market integration between urban and selected rural food markets in South Africa for the period of November 2006 to July 2012. The selection follows the decision which was made by the NAMC and Stats SA in the survey design. Collecting price data on a monthly basis from all South African urban and rural food chain markets can be a huge and expensive task to conduct. For this reason, the study is based on the available price information from selected rural and urban markets. Regions that were not covered in the FPM did not form part of the study.

Secondly, price data from all urban/regional markets might have been available from Statistics South Africa (Stats SA). Urban to urban food price analysis could provide a broad overview of spatial market integration. However, the focus of

this study is on the integration between the rural and urban markets. In addition to food price analysis, it is important to note that the prices are collected by human beings and there could be errors in the recording of data. To be certain in this investigation, it is assumed that price data is error free.

Thirdly, there might be additional important factors that could have an impact of the price transmission process in the urban and selected rural markets. The factors might include, among other things, distance between markets, transportations costs, and infrastructure, such as tarred roads, marketing structure (facilities) and communication. Information on these factors was not available and therefore did not form part of the modelling process of price transmission between the food markets under the study.

Lastly, the study did not conduct analyses on rural to rural market integration. This was based on the assumption that rural markets purchase maize meal from agro-processing companies and wholesalers based in the urban markets.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides a literature review of the studies which have been conducted on spatial price transmission. The review concentrated on the foundation of spatial markets and on frameworks that can be used to measure the relationship between urban and rural food markets. The chapter is organised as follows: section 2.2 provides the theory of spatial markets, section 2.3 discusses pricing in spatial markets, market integration is explained in section 2.4, and section 2.5 provide review of empirical evidence on market integration. Analysis of spatial markets is provided in section 2.6. Market efficiency and determinants of market efficiency are explained in section 2.7 and 2.8. Methods of measuring market integration are discussed in section 2.9. The chapter ends with a summary and conclusion (section 2.10) on the spatial price theory and the approaches that can be used to analyse data.

2.2 Spatial price theory

Spatial price theory states that price differences between regions cannot exceed transaction costs (Tomek & Robinson, 1995). If the price difference between regions exceeds transactional costs, buyers will purchase commodities from the low price market and ship them to the high price market. This will raise prices in the lower price market and reduce prices in the high price markets. Market agents make use of these market imbalances as an opportunity to trade between regions (Tomek & Robinson, 1995). This form of economic trade between two or more regions is termed arbitrage. As long as there is oversupply in a market and shortages in other markets, arbitrage conditions will continue until price differences between markets do no longer exceed transaction costs.

According to Meyer (2006), arbitrage has the effect of causing prices in different markets to converge and, therefore, for markets to integrate. If the arbitrage conditions are violated, it means there is a problem with regard to trade and this can be viewed as evidence of poor spatial market integration (Baulch, 1997). Spatial price theory sets a foundation as to how markets are related with each

other. If markets are not integrated, products will not easily move between market locations and consumers in non-integrated markets might be made worse off by the traders who do not receive market signals. In the section that follows, pricing in spatial markets is explained.

2.3   Pricing in spatial markets

Price is an important element in the functioning of markets. Price guides production, processing, distribution and consumption decisions (Tomek & Robinson, 1995). Within the spatial market context, differential pricing forms the base for markets' existence, as it provides signals to the marketing agents to engage in trade. Higher or lower prices have implications for business operations in regional markets. When the price is high, it becomes profitable for traders to engage in business, but when prices are lower, trade can still occur but consumers benefit more. Maize is an important single varied input in the production of maize meal; hence there will always be mismatches between market locations owing to surplus and deficit production regions. Moreover, maize is a seasonal crop linked to international trading systems and therefore fluctuation in prices will continue to exist in spatial markets.

In a competitive market environment, price is determined by market forces of demand and supply, although there are many other factors that lead to price formation. The factors include, for example, exchange rates, interest rates, and foreign and domestic policies, all of which fall within the ambit of micro- and macro-economic policies. According to Zanias (1993), policies have an effect on price formation. Therefore, international and domestic policies affect price formation vertically and horizontally, and have effect on the price that is paid by the consumers. With the effect of horizontal price transmission between markets locations, it is important to understand the meaning of market integration as being fundamental to urban and rural price formation.

2.4   Market integration

Spatial market integration can be defined as co-movements of food prices across integrated market locations (Goletti *et al*., 1995). The definition takes into account consistently smooth price transmission where there are no information

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barriers among the market traders. Negassa, Meyer and Gabre-Maldhin (2003) define market integration as a measure in which shocks that emanate from market forces are transmitted between different market locations. Accordingly, when there is a price increase or decrease for integrated markets, there will be adjustments in terms of price and volume. The adjustment process ensures that there are no significant price increase differences between spatial markets, unlike when markets are not integrated.

Without spatial market integration, price transmission will not occur between urban and rural food markets. This will cause price volatility among the markets and agricultural producers will not be in a position to specialise in the commodities in which they have comparative advantage (Baulch, 1997). For example, if maize prices become volatile spatially, there will be implications for the price of maize meal because maize is the greatest varied input into the production of maize meal. As a result, there will not be an incentive to trade in this agricultural commodity. Market integration leads to price stabilisation because of detailed transmission of incentives across the marketing chain (Amir, Babar, Muhammad & Fazal, 2011). Thus, non-uniform prices across space and time will incentivise traders to participate in the markets, either through distribution of the products and storage.

With market integration, price changes in one market are consistently reflected in another market (Goodwin & Schroeder, 1991). In this regard, the study of market integration will be incomplete without the inclusion of the Law of One Price (LOP). The law states that, under competitive market conditions, all identical products must have the same price, differing only in transaction costs. Kohls and Uhl (1998) define LOP as a condition in which prices in the markets are uniform after taking into account time, form and cost of adding a price in the market. According to the FAO (2004), in a frictionless and undistorted world, LOP is supposed to control price relationships, and the price of agricultural commodities along the value chain will depend on production-related costs. Because of different transactional costs between regions, price differentials between geographically separated locations create incentives for market actors to engage in the exchange of goods and services.

When markets are not integrated, prices do not give appropriate signals for trade to take place (Viju, Nolan & Kerr, 2006). However, Hernandez-Villafuerte (2010) has pointed to distance between markets as being the possible factor that leads to lack of market integration. Further, where there is no market integration, price differentials might be found to be excessively high, compared with markets that are integrated, for reasons such as poor public infrastructure, lack of competition, and incomplete market information flow.

2.5   Review of empirical evidence

Market integration is one of the important studies that are conducted in the world in order to assist countries with development. Empirical evidence shows many authors for example, Goletti *et al.*, (1995), Penzhorn and Arndt (2002), Meyer, (2003), Minot, (2011), Abidoye and Labuschagne (2014) who have studied and/or tested market integration through spatial price transmission process.

Goletti *et al.*, (1995), conducted a study on structural determinants of market integration in Bangladesh on different rice markets. The authors used four measures of integration to analyse time series data namely, correlation of price differences, co-integration, long term multipliers and speed of price adjustments to long run. The results of the first stage showed that the average correlation co-efficient of price changes was 0.23, the average absolute value of co-integration was 3.71 and the long term adjustment was 61%. Lastly the study found that it takes about 2.6 weeks on average for integration. Goletti *et al.*, (1995) concluded that the results show moderate amount of integration and suggested appropriateness of aggregate price policies that are not region specific. On the structural determinants (which are referred to as second stage) the authors used structural data such as distances, rail density, paved roads, telephone density, and number of shocks to production amongst others. The results of the second stage showed that structural factors have positive and negative significant effect on market integration. The major conclusion provided by Goletti *et al.*, (1995) is that different measures of integration respond

differently to the same structural factors. The study suggested improvements of existing roads which may improve the extent of market integration.

Penzhorn and Arndt (2002) conducted a study on maize markets in Mozambique and tested market integration. The study used Party Bounds Model (PBM) to test violation of spatial arbitrage. The results pointed failure of spatial arbitrage conditions between markets such as Maputo and Chimoio with about 23% of the time over the period. The study concluded that there were periods were markets were not integrated at all and that markets were not functioning according to LOP.

Meyer (2003) conducted a study on measuring market integration in the presence of transaction costs in Germany and the Netherlands pig markets. The study employed a Threshold Vector Error Correction Model (TVECM) and compared adjustment process with the results from using VECM. Weekly price series data from the period of June 1989 to the end of March 2001 was used in the analysis. The results of the study showed that price adjustment process employing VECM differ significantly from using TVECM. The VECM results showed that German and Netherlands prices react to deviations from the long run equilibrium but the TVECM indicated no significant reaction of the Netherlands price to the deviations. Due to differing of study results, Meyer (2003) suggested development of three regimes.

Minot (2011) examined the degree to which changes in the world markets influence the price of staples in Sub-Saharan countries. More than 60 price series from 11 African countries was employed in the analysis. The study used Error Correction Model (ECM) to estimate the degree of price transmission. The results of the study showed that stable food prices in the African countries rose by 63% between mid 2007 and mid 2008. Statistical analysis of between 5 and 10 year period also showed a long term relationship in 13 of the 62 African countries food prices. Key to the findings was that the African rice price was found to be more linked to the international markets than maize prices. Minot (2011) suggested that African countries can reduce vulnerability to external food

price shocks by facilitating grain trade, promoting diversification in staple food consumption, pursue predictable policies and to invest in research.

Abidoye and Labuschagne (2014) conducted a study on the transmission of world maize price to South African maize market. The study used threshold co-integration to establish if price transmission occurs. The results of the study showed that thresholds exits between the markets and that, small changes in the price of maize in the world markets are not transmitted to domestic maize markets in South Africa, only larger long run deviations in price were transmitted. The results further showed that international prices take longer to be transmitted to the South African prices when markets trade at export parity compared to when markets trade at import parity. The study by Abidoye and Labuschagne (2014) provided an understanding of how world prices affect South African domestic prices on maize and suggest a way in which food security policies could be developed looking at linkages with international markets.

The review of empirical evidence provided is not exhaustive list of the studies on spatial market integration. Review of the studies given necessitated the need for spatial price analysis.

2.6   Spatial price analysis

In analysing price relationships between spatial markets, attention has been drawn to the use of spatial price equilibrium models. The models of spatial price relations were developed by Enke (1951). Under rigid assumptions, spatial price models can help in the estimation and determination of the net prices that can exist between markets. The models can further provide the quantities that can be sold or purchased from each market. Such models enable one to determine the least-cost trading patterns (Tomek & Robinson, 1995). Samuelson (1952), Takayama and Judge (1964 & 1971) showed that the spatial price equilibrium can be used to solve external economic problems in the determination of prices and commodity flows between markets. The spatial price models therefore provide a convenient analytical framework that can be employed to determine

the indirect and direct changes in production from one region to the other, including the volume and the possible direction of trade.

Spatial price relationships serve as an important indicator in the measuring of the entire market performance (Lohano & Mari, 2005). The degree to which market shocks are transmitted cross-spatially to distinct markets has long been considered to be an important indicator of market performance (Hernandez-Villafuerte, 2010). A spatial price linkage therefore provides insights into whether pairs of markets are integrated and as to whether the same markets are efficient in the provision of basic foods. Spatial price relationships are largely determined by transaction costs between regions provided competitive conditions prevail (Tomek & Robinson, 1995). Transaction costs are the most important components that lead to price differentials between spatial market locations. However, there are other important transfer costs, such as loading, handling, storage and marketing costs that need to be considered within the spatial market analysis.

Analysis of spatial price relations will be incomplete without taking into consideration LOP, and therefore many researchers have extensively studied LOP in order to verify commodity price adherence to LOP (Ardeni, 1989; Baffes, 1991) and market integration (Ravallion, 1986; Zanias, 1993; Gardner & Brooks, 1994; Goletti & Babu, 1994). These studies concluded that adherence to LOP is limited. The limitations of LOP might suggest that there are commodity prices that do not adhere to LOP, while some researchers have criticised the methods used for analysis owing to mixed results.

Recent research by Amir *et al.* (2011) tested LOP in seven selected pulses markets of Pakistan using co-integration analysis. The study used monthly wholesale price data from January 1991 to December 2006. The authors found that the seven markets prices were strongly co-integrated and that there was convergence to long-run equilibrium. Amir *et al.* (2011) showed that Pakistan gram markets were stationary in four directions and the directions changed to non-stationary for the other three markets. The study therefore found that LOP

holds and confirmed that linkages and interrelationships between markets are necessary in the study of spatial relations.

In spatial contexts, smooth price transmission can be obstructed by a number of factors. These include domestic price policy support, exchange rates, market power and transactional costs. Governments can make direct interventions in the functioning of the markets through use of exchange rate policies; these can prevent full price transmission between markets (Knetter, 1993). Although other factors might affect smooth price transmission in South African markets, it is important to note that South Africa does not have price policy support in the production of maize and in the maize meal product value chain. Because of the international trade in commodities and in maize products, other policy measures that can obstruct trade between countries or regions include non-tariff measures, which have negative effects on price transmission between regional markets (Zanias, 1993; Thompson, Sul & Bohl, 2002). This will consequently lead to problems of efficiencies in the marketing environment.

2.7   Market efficiency

Market efficiency can be defined as a condition in which demand is equal to supply and where costs are minimised in the process (Rashid, *et al.*, 2010). This definition suggests an equilibrium condition where demand for a product is equal to supply. Markets are not often in equilibrium owing to seasonality of the produce. Oversupply leads to price reduction, while excess demand leads to high prices in the market place. According to Fama (1970), market efficiency can be achieved if the price contains all the information set. This is when the price of a commodity is not affected by other factors outside the value chain and shows all the information that is required by market participants. Price information is very important in agricultural markets. It serves as a signal to all actors and can indicate whether markets are integrated and efficient. Illustrations of market efficiency can better be understood within the context of two markets trading with each other. For example, two markets are said to be efficient with regard to the trade of a commodity if the price in the exporting market is equal to the price of the same commodity in an importing market, taking into account transportation and transaction costs.

Transaction costs are important in the marketing of agricultural commodities and products. They include search costs, identification of markets, negotiation and ascertaining the behaviour of traders and are very important for the efficient functioning of markets. If transaction costs are higher than price differentials, market agents will be discouraged from engaging in trade. High transaction costs serve as a barrier to trade and lead to lack of market integration and market inefficiency. On the other hand, markets can be integrated without being efficient. Trade will occur when there are large price differentials between markets, and there can even be faster price adjustments when prices change, even if markets are inefficient (Rashid *et al*., 2010).

Spatial market integration can be regarded as neither a sufficient nor necessary condition for market efficiency, so tests for market integration do not always generate the appropriate inference regarding efficiency of the markets (Fackler, 1996; McNew & Fackler, 1997; Fackler & Goodwin, 2001; Barrett, Li & Bailey, 2000; Barrett & Li, 2002). However, markets are often inefficient and do not integrate for various reasons, such as lack of competition, poor or inadequate infrastructure, particularly roads, inefficient flow of information between markets, and government interventions into the markets. Rashid *et al.* (2010) argue that factors, such as credit institutions and insurance, are the potential sources of failing markets. There are various factors that lead to market inefficiency or efficiency; therefore it is important to explain the determinants of market efficiency.

2.8   Determinants of market efficiency

There are three main determinants of market efficiency, namely market information, competition and public infrastructure. Central to these determinants are the transaction costs which lead to efficiency or inefficiency of the markets. The three determinants are discussed in the section that follows.

2.8.1   Market information

Marketing information, especially price formation, is an important component in the functioning of markets. Market information can assist in the development of

plans, budgets and strategies by traders. In addition, market information can help in the prediction of future prices and can lead to rational decision making among the market actors. Availability of agricultural market information can reduce transaction costs and the risk of doing business, and can further allow market actors to explore trade opportunities (Robbins, 2000). Lack of agricultural marketing information can lead to inefficiency in the market, and as a result, markets might not integrate.

Information is necessary to assist in the making of decisions; however, it is not a free commodity and there are always costs attached to information. The cost of information arises as a result of gains from its use and the fact that agri-business companies use their scarce resources to collect and analyse information for trade. Because of their private nature, they have intellectual property rights which serve as a barrier to the free distribution of information. It is, therefore, difficult and challenging for fair engagement in a spatial context, as some agents will tend to behave in a different way owing to lack of market information.

Acquiring market information further involves added costs, called transaction costs. Literature distinguishes between two types of transactions costs, namely observable and non-observable costs (Stall, Delgado & Nicholson, 1997; Delgado, 1995). Observable transaction costs include the cost of storage, spoilage, handling and transportation of products among the regions. Non-observable transaction costs are difficult to attach value to and these are search costs, screening, negotiation, enforcement and monitoring, and evaluation of transactions (Bardhan, 1984). Unfortunately, traders incur all the costs mentioned and factor these costs in the marketing to the products.

Markets work better and more efficiently when there is a smooth distribution of information across market locations. However, facilities, such as infrastructure, might be a barrier to accessing information and this can be even more problematic in rural food markets, as compared with urban food markets. It can be argued that rural market actors have less market information, which might lead to inefficiencies, as compared with urban market actors who are located in

city centres, and that urban markets can be more efficient. It can be difficult to determine the impact of agricultural marketing information, given the facilities' constraints. Aker (2010) conducted a study among grain producers in Niger and estimated the impact of mobile phones as a facility that transmits marketing information. The author found that mobile phones were effective in the transmission of information among the grain markets and reduced price dispersion by 10 to 16 %. This suggests that if rural market actors can use facilities, such as mobile phones, for price information transmission, markets can become integrated and competition might prevail.

2.8.2 Competition

In a competitive market economy, price signals transmit information to all market participants so that informed decisions are made. Decisions on consumption are taken by consumers and decisions on what needs to be produced are taken by the producers. A competitive marketing environment further allows interaction between demand and supply to become the price formation mechanisms. If price changes in one market cause a price change in the related market, then such markets are said to be integrated. However, market integration in itself does not imply that markets are competitive (Baulch, 1997). There might be excessively high price differentials between the markets, which may point to a lack of competition among market participants. Two types of competition can be distinguished, namely perfect and imperfect competition. In perfect competition, there are many firms which are small, as compared with the market, and none is large enough to affect the price, hence all firms are price takers. In a perfect competitive market, firms are driven by either locative or pareto optimality. Important to competitive marketing is the existence of demand and supply which lead to the formation of affordable pricing, which can further be translated to normal profit.

On the contrary, in imperfect competition, firms have control measures over commodity prices. This means that firms can charge prices that lead to super profits as a result of inefficiency that may exist in the allocation of resources. Super profits can denote that prices are excessively high and this might lead to lack of competition among markets, suggesting poor market integration.

Imperfect competitive behaviour can be seen in the marketing powers often used by monopolies and oligopolies.

When imperfect competition and market power exist in marketing structures, some marketing firms can behave as price makers, while other actors might behave as price takers (FAO, 2004). Osborne (2005) conducted a study in Ethiopia and tested for imperfect competition among smaller and larger markets. The author found that imperfect competition existed among the wholesalers in smaller markets that were separated from the main city markets and found no evidence of imperfect competition among the larger markets. However, the existence of imperfect competition among the smaller markets was found to be moderate, with only a 3 % product price reduction.

Zachariasse and Bunte (2003) point out that market power can be important to explain the lack of full price transmission between markets. With this context for example, a firm located at a distance from the other marketing firms can use its power to influence prices in the market and this action can lead to poor market integration. Market power and imperfect competition by the marketing firm's behaviour can negatively impact the functioning of markets, thereby leading to poor integration. Weldegebriel (2004) conducted a study on imperfect price transmission and found that the food markets under study were characterised by both oligopolistic and oligopsonistic power. However, Weldegebriel (2004) argued that when using perfectly competitive markets as a base in the price transmission process, oligopoly and oligopsonistic behaviours do not necessarily indicate imperfect price transmission. Competition plays an important role in agricultural markets and has an impact on the price transmission process, but good public infrastructure can promote competition among the market participants.

2.8.3 Public infrastructure

Public infrastructure, such as road quality, contributes to smooth trade between regions and can lead to market integration. Limao and Venables (2000) conducted a study on transportation costs between inland and costal countries. The results of the study indicated that the inland countries had high

transportation costs of 60 %, which were caused by poor road infrastructure, and that the costal countries had transportation costs of only 40 %. Poor roads can increase transportation costs for delivery vehicles in a number of ways. These include higher maintenance costs, higher fuel consumption costs, depreciation of vehicles, tyre replacement costs and delays in the delivery of products. Buys, Deichmann and Wheeler (2006) argued that inland transportation costs are high and have led to the isolation of many African countries from trading opportunities.

Minten and Kyle (1999) conducted a study on transportation costs in the Democratic Republic of Congo (DRC). The authors found that poor roads doubled transportation costs, as compared with good roads. High transport costs reduce trade between regions and can lead to excessive food price differentials between markets. As a result of high transportation costs, many households which are located in rural areas are likely to experience high food prices owing to scarcity, as compared with urban dwellers. In a similar way, the degree of food insecurity will differ between urban and rural markets owing to excessive price differentials that might exist in market locations.

As a result of high transportation costs between surplus and deficit regions, relatively few African countries participate in the world markets by exporting their products. Coulibaly and Fontagné (2004) employed the gravity model to predict trade in western African countries. The result of the study revealed a significant effect of road quality on trade. Buys *et al.* (2006) also employed the conventional gravity model to make predictions about trade in African countries. The authors employed parameters such as quality of networking roads, distances between markets, import and export scales and membership agreements. Buys *et al.* (2006) found that a 1 % increase in good quality roads led to a 2 % increase in imports and exports of goods among African countries. Although the studies concur with each other on the impact of good roads towards trade, the elasticity's found by Buys *et al.* (2006) were somewhat higher than those obtained by Coulibaly and Fontagné (2004). The results of studies conducted in many African countries suggest that good roads lead to market

integration, as agents within the transport space may find it easier to trade between regions.

2.9 Measuring market integration

Understanding the interaction between urban and rural markets is vital, as this will inform policy makers on the regions that must be concentrated on in the development of the South African economy. In order to understand these interactions, maize meal prices are used mainly because price is important information in the marketing of products and can indicate whether markets are integrated. Agricultural markets are considered to be spatially integrated if there is a long-run price relationship or, stated differently, if prices of the same goods move together in a similar pattern. If such a price relationship occurs, it can then be measured, which in turn can provide an indication of market performance.

Market integration can be measured through tracking the movement of goods or flow of investments between marketing regions (Moodley, Kerr & Gordon, 2000). Literature on measuring market integration shows different approaches to measuring and analysing market integration. The approaches include correlation coefficient of prices (Lele, 1972); short- and long-run measures of integration (Ravallion, 1986); and long-term multipliers and time to adjust (Medonza & Rosegrant, 1991). Another method of measuring market integration involves the co-integration approach (Goodwin & Schroeder, 1991; Palaskas & Harris, 1991). Other authors, such as Mendoza and Farris (1992), used causality and centrality tests to measure market integration. With all the methods mentioned, the correlation coefficient and the co-integration measure of market integration capture price co-movements. The multiplier effects and speed of adjustment help in the capturing of dynamic price movements. All market integration approaches are discussed in the section that follows.

2.9.1   The correlation coefficient approach

Correlation coefficient analysis is the most common approach in econometric studies that is used to measure market integration. The price-series correlation approach relies on price data alone and does not take into account other information necessary to measure market integration. Correlation coefficient

analysis takes into account the fact that integrated markets have a tendency to show product prices that move together. As an approach to measuring market integration, correlation co-efficient analysis has advantages and disadvantages. Goletti and Babu (1994) argue that its use tends to cover important variables, such as seasonality and marketing policies, which are important in the measuring of market integration. The disadvantage of correlation approach is that price matrix levels can provide spurious relations which can lead to wrong conclusions in the measuring of market integration.

According to Delgado (1986), the use of correlation coefficient analysis can give lower price correlation results, which might lead to a wrong picture being formed about market integration, even when there is proof of competitive market behaviour among the market participants. Karugia, Wambugu and Oluoch-Kosura (2003) used correlation coefficients to analyse price relations in different markets in Kenya during the pre-liberalisation and post-liberalisation eras. The authors found a high correlation coefficient of 0.72 and 0.98 in the pre-liberalisation period and between 0.52 and 0.89 in the post-liberalisation period. According to Karugia *et al.* (2003), markets which were close to each other, had good transportation and developed infrastructure exhibited high correlation coefficients. The results supported the suggestion that short distances and well developed infrastructure lead to lower costs of doing business, which in turn make trading profitable among that market's agents and lead to market integration.

However, Barrett (1996) criticises bivariate analysis, stating that it is weak and cannot be relied on in the measuring of integration, as it gives high correlation results even for agricultural markets that do not have physical links. In case of Kenya, there seems to be linkages between markets attributable to proximities, good transportation and good infrastructure. The study by Karugia *et al.* (2003) contrasts the study of Delgado (1986) because high correlation coefficients were found in Kenya. Although the correlation coefficient is not the finite approach to measure market integration for this study, it would be interesting to run a correlation matrix so that the results might be compared with the studies conducted by Delgado (1986) and Karugia *et al.* (2003).

Noting that the use of a correlation approach can lead to spurious correlations, Goletti *et al.* (1995) suggested the employment of price differences in calculating correlations, instead of using price levels. This is because price levels have many problems, including non-stationary price series. An alternative to non-stationary series could be the differencing of data until is stationary and then to run price correlation matrix. There seems to be challenges and limitations associated with the price correlation approach to market integration. In order to tackle the problems of price correlation, Autoregressive Distributive model and a co-integration approach is suggested to measure market integration.

2.9.2   Autoregressive distributed lag method

According to Ravallion (1986) static bivariate method can be extended into a dynamic model of spatial price differentials which can avoid the dangers of spurious correlation. To this effect, Autoregressive Distributive Lag (ADL) or Rational Distributive Lag model as defined by Wooldridge (2013), was developed as a single regression equation to estimate the relationship between dependent and independent variables. The ADL model can also address the problem of incidental co-movements of variables which the correlation based approach failed to address. Another problem in econometric analysis is the fact that many time series data are often non stationary. The ADL model therefore requires that data be de-trended first before its application in order to estimate the long run and short run dynamic relationships.

Literature on distributive models distinguishes between two types of ADL model, namely Distributive Lag (DL) and Autoregressive (AR) model. The DL models consist of lagged values of the explanatory variables and summarise the dynamic effect that a temporary increase in X (X_{t-1}, X_{t-2}) has on Y (Wooldridge, 2013). With DL application, the effect of an explanatory variable on Y occurs over time. The AR models include lagged values of dependent variable as explanatory variables. Combination of the two models (DL and AR) forms the ADL model. The ADL model uses lagged differenced values of Y (ΔY_{t-1}), lagged

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difference values of X (ΔX_{t-1}) and the differenced current value of the explanatory variable (ΔX_t) to predict the effects of the Y variable, which must also be in a stationary form. The ADL model is employed to test the null hypothesis of 'no effect of Y'. The model was applied in econometrics analysis by Ravallion (1986) for establishing the long run and short run dynamics relationship. However, ADL is without limitations, the short-coming of the ADL model is that the model can provide inefficient parameters estimates which might lead to wrong inferences. The other approach which is suggested for use when spurious relationship occurs is the co-integration approach which is explained below.

2.9.3   Co-integration approach

Co-integration is an extension of simple correlation-based analysis and it takes into account non-stationary prices in the evaluation of spatial market linkages. The approach emerged in the 1980s as an important technique that helps in the analysis of markets linkages. According to Goletti and Babu (1994), co-integration can identify the degree of market integration and can provide more information about the direction of trade. The technique is used to establish long-run relationships among product. Short-run dynamics can occur when there is no long-term relationship or when there is no co-integration in the variables and different techniques can be used to determine its existence. While correlation is based on return data, co-integration is based on raw or yield data. With the urban and rural price information, co-integration analysis can assist to find if there is a long-run relationship between urban and rural food markets prices.

Engle and Granger (1987) and Johansen (1988) provided a procedure for the testing of a long-run relationship between non-stationary price series. The procedure follows the use of Augmented Dickey Fuller (ADF) tests. Procedurally, ADF is employed first to test non-stationary price series. This will then give an indication of variables that have a unit root or those that are stationary at first level. Variables that are non-stationary are then used for co-integration analysis, provided they become stationary, say, at first level. If there is co-integration, it means change in price from one market is reflected in the

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other markets and markets are integrated. Johansen's (1988) procedure to test co-integration is based on multivariate tests. The procedure involves the use of the maximum likelihood test ratio and relies more on ranked matrix and unit root characteristics. Johansen employs two methods in testing co-integration: these are the Trace Test and the Maximum Eigenvalue test.

Prices of products change over time because of shocks that occur in the markets. However, if a stable long-run relationship proves to exist among products prices, it can then be said that co-integration exists. The existence of co-integration among price series can then be interpreted as an indication of market integration. On the other hand, price series that tend to drift away from each other over a longer period can be interpreted as having lower co-integration and as an indication of poor market integration.

According to Goletti *et al.* (1995), co-integration of price series shows markets that are integrated and if there is no co-integration, it means that markets are not linked. A non-linked market cannot be accepted in both directions, while a connected market can be accepted in both directions. Goletti *et al.* (1995) studied market integration of rice in Bangladesh, and found that out of 64 markets that had 2 016 links (64.63/2), there were 667 links separated by distance of 250 kilometres, and among the latter only, about 44 links were segmented. The 44 market links that are segmented meant that there is no co-integration.

Many authors argue that co-integration analysis is an insufficient technique to be used in the analysis of spatial markets (Barrett, 1996; Fackler & Goodwin, 2001; Barrett & Li, 2002). The technique is insufficient because it assumes that transaction costs are stationary. Stationary price series are required to measure market integration and therefore econometric techniques have been developed on the assumption that price series should be stationary. Stationary price series imply the existence of at least a stable unconditional mean and variance, which can be a challenge to achieve in economic analysis. Statistically non-stationary variables are differentiated repeatedly until stationarity is achieved, and then the series can be modelled. Co-integration has its own shortcomings and it cannot

be employed alone to measure spatial price relationships; therefore, other econometric methods, such as a threshold approach, can be used.

2.9.4   Threshold co-integration approach

Many time series data appear to be non-linear and require the use of an appropriate model that will capture dynamic relationships. Non-linearity of price data can be attributed to inflation and it is important to capture non-stationary data with a model. One of such models is Thresholds Autoregressive (TAR), which was developed by Tong (1978). The TAR model takes into account the non-linearity of price data and assigns a variable to the respective threshold value. TAR also takes into account the effect of transaction costs in the measuring of market integration, as compared to correlation and co-integration approaches. Research into econometric modelling by Balke and Fomby (1997) made further developments to the TAR model by bring the non-linearity and co-integration method together. Development of threshold models has led to the Error Correction Model (ECM), which is used to model dynamic price movements and can relate the current prices with the previous time series prices, when co-integration exits. The threshold models discussed give a general specification of modelling non-stationary data and can reduce use of different modelling. For example, TAR can change to ECM when adjustment is symmetric in the error term (Balke & Fomby, 1997) and ECM can change to a VAR in difference when unit root exists but there is no co-integration.

In addition to the models discussed above, there is the latest approach which was developed to assist in the analysis of price transmission processes and can further assist in the dynamic price adjustment process. The model developed is the Threshold Vector Error Correction method (TVECM). The model takes into account the effects of transaction costs, which is commonly unavailable, according to Meyer (2003). The method avoids what Baulch (1997) called the indirect testing and measuring of market integration. TVECM does not use actual data of transaction costs through the analysis and still assumes that transaction costs are constant.

Threshold models have been established on the assumption that the existence of transaction costs creates an interval which is called a "neutral band" (Goodwin & Piggott, 2001). Within the neutral band regime, agricultural product prices from spatial markets are not connected to each other. Further, the price differentials between two spatial markets are very much smaller than transaction costs, or are close to zero, thus no arbitrage is possible to turn price differentials back to price parity equilibrium. By contrast, within other regimes, adjustment to the price parity equilibrium is expected to occur reasonably quickly (Alemu & van Schalkwyk, 2009).

Balke and Fomby (1997) refer to co-integration as having a "global characteristic", while the threshold models are referred to as possessing a "local characteristic". This is because in threshold models, equilibrium is restored when local price shocks create a price difference that is greater than the "neutral band". Goodwin and Piggott (2001) argue that the use of threshold models results in quick price adjustment to equilibrium when deviations occur. The major advantage of threshold co-integration is that it does not need observation of transaction costs. The other model that can be used in the measuring of spatial market integration is the Parity Bound Model (PBM), which is discussed in the section that follows.

2.9.5   Parity bound model to spatial market integration

A Parity Bound Model (PBM) is another model that can be used to measure spatial market integration. Baulch (1997) developed the PBM and argued that many researchers had been measuring market integration indirectly using price series alone, and did not take into account the important role that is played by transfer costs. The PBM model and its application can be found in Spiller and Wood (1988). PBM has been further refined and applied by many researchers (Sexton, Kling & Carman, 1991; Baulch, 1997; Barrett & Li, 2002; Penzhorn & Arndt, 2002).

PBM can help to distinguish between market efficiency and spatial market integration. However, this depends on the availability of trade flow information, the prices of goods and on transaction costs information. PBM takes into

account the effects of transfer costs, which consist of activities such as loading and transportation of products from one location to the other, including the costs of unloading goods. The model further allows for the transfer costs to vary and does not make assumptions on the nature of marketing margins. PBM can help to estimate time series data that are incomplete, as is often the case with many price data that emanate from developing countries (Penzhorn & Arndt, 2002).

PBM can measure the chances of being in different trade regimes and can further provide information on the extent of market efficiency (Negassa *et al.*, 2003). Sexton *et al.* (1991) and Baulch (1997) have identified three possible trade regimes, which are described as follows. Regime one occurs when prices across market locations differ, but such difference is equal to transfer costs. This means there is competitive trade among the regions and prices move together in similar patterns. Regime two occurs when prices across market locations differ, but such difference is too small for market actors to engage in trade. This means there is no competitive trade among the regions and prices do not move together. Regime three occurs when prices across market locations differ, but the differences are greater than the transfer costs. This might mean that there is imperfect competition in the market, or it might indicate temporal disequilibrium. PBM has its own shortcomings and has been criticised on several grounds. As applied by Baulch (1997), PBM still falls prey to problems of non-stationary transfer costs. PBM has been criticised for being a bivariate analysis and that it cannot be used to analyse many agricultural products (Gonzalez-Rivera & Helfand, 2001). Fackler (1996) argues that PBM has no link to economic theory and therefore the model cannot be used to make economic conclusions.

2.10   Summary and conclusion

In this chapter a theory of spatial price and spatial pricing was discussed. Key to the chapter discussions was the differential pricing mechanisms which can trigger trading opportunities when price differences between the market locations exceed transaction costs. However, it is important to highlight the fact that although trade in maize meal might occur between market locations, it will always be affected by mismatches of product availability attributable to maize

meal linkages to seasonality and variability. With regard to trading opportunities, the activities are likely to occur when price differentials exceed the transaction costs. It was important to make a review of the methods that are used to measure integration. The methods reviewed are as follows: correlation approach, Autoregressive distributed lag method, co-integration approach, threshold co-integration and the PBM.

Early studies of measuring market integration employed correlation methods. However, it was discovered that the method can provide spurious relations, such as high or low correlations even when no market integration existed. Moreover, the method could not take into account transaction costs. Development in the models of measuring market integration led to the extension of correlation to the co-integration method. The technique is employed to establish a long-term relationship between variables. An argument about co-integration tests is that the technique assumes stationary transaction costs and therefore it cannot be used alone. Threshold co-integration is suggested for use, together with the co-integration approach. One such model is TAR, which takes into account the non-linearity price data and assigns a variable to respective threshold values. TAR also takes into account the effects of transaction costs.

Development of TAR led to ECM, which models dynamic price movements and can relate current price with previous price, econometrically. Other models developed for use in spatial market integration are the TVECM and PBM. These two models can handle non-linearity of price data and transaction costs. Regime changes are used in the models mentioned to ensure different adjustments to long-run equilibrium. All models discussed have their own short-comings and therefore the choice of model will depend on the research objective being pursued. The primary objective of this study was to measure spatial market integration. In order to achieve this objective, key was to establish if there is price transmission and/or establish if there is price relationship between urban and rural food markets. The model employed for establishing co-movement of prices was co-integration with the VECM estimating the co-integrated parameters. Although TARs or PBM could have

been employed in the analysis, the intension was to capture even small price changes between the markets when trade of the 2.5kg maize meal occurs and these is not the case with TARs as showed by Abidoye and Labuschagne (2014).

CHAPTER 3: MAIZE INDUSTRY OVERVIEW

3.1 Introduction

This chapter provides an overview of the maize industry in South Africa. It focuses on the following aspects: the historical and the current maize industry profile, production of maize in different regions, its processing and distribution, and the value it derives from various marketing channels. The chapter concludes with analysis of the maize meal industry on aspects of price trends, price levels, price relationships and variability in different market locations.

3.2 Industry background

The South African maize industry is by far the largest maize industry in Africa (NAMC, 2004). Historically, the South African maize industry operated under a regulated environment. This led to the commercial production of maize (both white and yellow) where the marketing of the commodity was fully under the control of a maize board. Marketing of maize by the maize board represented a single channel which restricted some growers, particularly smallholders and small agro-processing companies, from participating in the mainstream markets. Restriction was mainly enforced through the Marketing of Agricultural Products Act of 1937.

The maize industry was de-regulated in 1997, which marked the end of the Agricultural Marketing Board. Deregulation was expected to increase participation of many role players, especially small-scale growers and small agro-processing companies, who were excluded by the single marketing channel. It was further meant to shift the managing of commodity risks to the private sector, to increase investment and employment, and to reduce subsidies from the government. As a result of deregulation, many industry organisations were formed and are mostly operating as Section 21 companies. Within the maize industry, Grain SA and the industry marketing information arm, the South African Grain Information System (SAGIS) were formed. De-regulation further led to the establishment of a new trading system in the maize industry, the South African Future Exchange (SAFEX). Currently, and since 1997, maize

prices are determined under the free market system with SAFEX as the main price discovery mechanism for farmers, speculators and millers (Sturgess, 2010).

Maize is an important food security crop for most of the households living in South Africa. The crop is produced in large quantities by about 9 000 commercial farmers and is produced to a lesser extent by an unknown number of smallholders (DAFF, 2012). Smallholder farmers are scattered all over the country and commercial growers are mainly found in the production regions. Climatic conditions are best suited for the crop as maize is produced under both dry land and irrigation.

There are three major production areas in South Africa, namely the Free State (FS), North West (NW) and Mpumalanga (MP) provinces. The maize crop is produced in two categories, namely white and yellow maize. White maize is primarily used for human consumption and yellow maize is used as feed for livestock. Approximately 60 % of the white maize is used for human consumption and 40 % is used as feed for livestock (DAFF, 2012). Although seed is required for re-planting purposes, it is important to note that its volume is insignificant.

3.3   Gross value of maize industry

The South African maize industry makes a significant contribution to the economy through trading of maize in the local and international markets. During the 2011/2012 marketing season, the industry realised a Gross Value of Production (GVP) of about R24 billion. as depicted in Figure 1 below. However, fluctuations in the crops occurs owing to various factors and therefore the industry average GVP is estimated at around R13 billion per annum. For example, during the 2007/08 season, the industry experienced a high GVP of about R22 billion, and in the following marketing season (2008/09) the GVP declined to R16 billion, representing a decrease of 38 %.
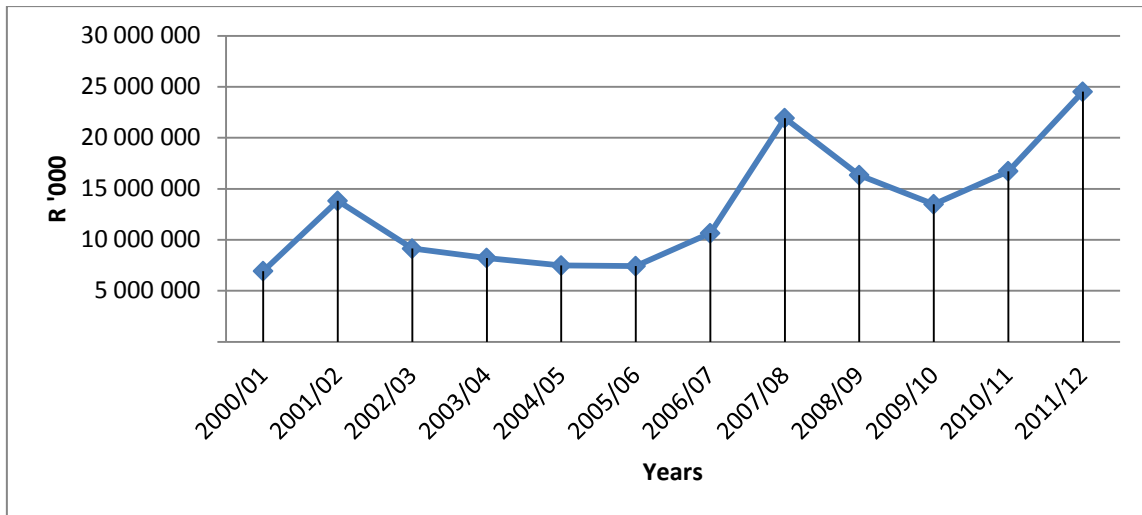
Figure 1: Gross value of production for maize

Source: DAFF, 2013

3.4 Hectares planted with maize

In South Africa, commercial farmers plant, on average, 2.5 million hectares per annum, while smallholder farmers plant, on average, 500 000 hectares (GAIN, 2013). The area planted with maize fluctuates annually, although it appears that the industry is experiencing a declining trend in the area planted (see Figure 2 below). The reasons for fluctuations in area planted can be attributed to large stock produced in the previous years, uneven rainfall patterns in production regions, droughts, fluctuation in prices of both white and yellow maize per ton according to the SAFEX trading system, and international supply and demand of maize. The decline in hectares planted could be an indication that maize production is being substituted with other commodities that might be of value to the maize growers, and most importantly owing to changes in consumer preferences to other energy sources (NAMC, 2010). Moreover, there seems to be a relative switch between white and yellow maize. The main reason for this is that as income increases, the demand for other produce, such as chicken, increases. This implies that the demand for feed will ultimately increase. The demand for white maize is relatively stagnant and with increasing yields, the area under white maize will come down.

Maize is considered to be a food security crop in SA, from the food security perspective, and with the current increase in population, the decline in area

planted with maize might be considered a concerning factor. Households who depend on maize meal might find it difficult to survive in the long run if there were to be a continual decline in the area planted. This is because a continual decline in area planted with maize leads to a reduction of volume of production, which will in turn trigger white maize meal price increases. According to the NAMC (2010), the majority of lower-income earners live in rural areas, and this implies that rural household will be more affected by price increases than urban dwellers.
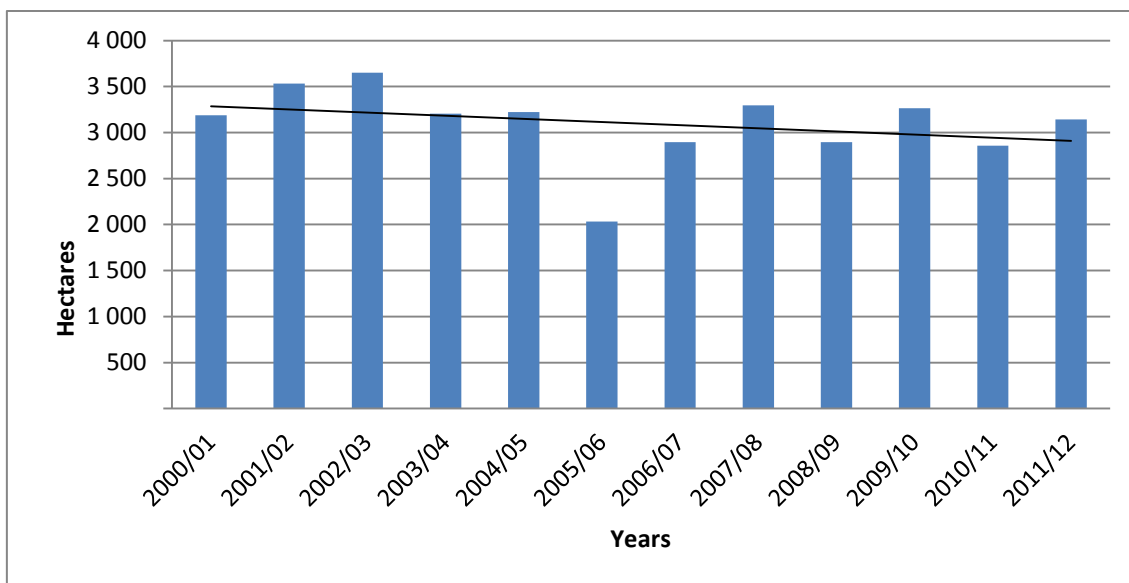
Figure 2: Hectares planted with maize

Source: DAFF, 2013

3.5   Maize production volume

The maize industry produces approximately 10 million tons per annum. Over the last 12 years of production seasons, the industry produced, on average, 10.5 million tons, as depicted in Figure 3 below. The volume of production varies from year to year and there are many factors which contribute to fluctuation of production volumes. Climate change related factors, such as rainfall, flood, and drought, and diseases are the main factors that contribute to higher or lower volumes of production. Other factors include stocks in local and international silos, spot prices of maize as per SAFEX, and rand–dollar exchange rates. All the variables mentioned lead to an unstable environment in the maize industry, hence the Crop Estimation Committee (CEC) assists the

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industry with estimates of production on a yearly basis. The CEC recommendations inform the growers and various stakeholders as to the expected volume of maize production. Although the CEC takes some of the uncertainty of the crop, all the other risk factors remain present. The same goes for SAFEX which manage the price risk, but it does not take the price risk away.
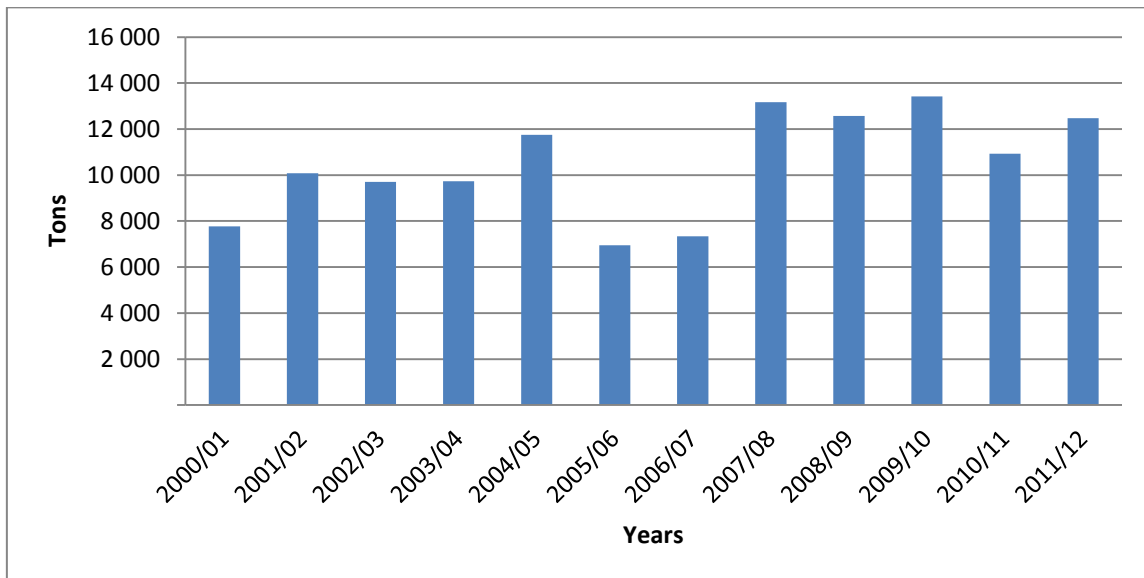
Figure 3: Total maize volume produced

Source: DAFF, 2013

3.6 Price of maize as per SAFEX

Following the abolishment of grain marketing boards in 1995, prices of grains are determined through the SAFEX system. However, before examining the relationships in grain prices, it is necessary to explain the SAFEX commodity derivative system. The SAFEX trading system provides a price risk management and price discovery platform to the Southern African growers, speculators and millers (Sturgess, 2010). The system was bought out by the Johannesburg Stock Exchange (JSE) in 2001. It integrates demand and supply of grain worldwide to determine the local trading price. With SAFEX grain commodity derivative instruments, prices are determined daily, except during weekend and holidays when the market is closed. Participants include hedgers, such as farmers, miller and speculators. In 2009/10 there were about 50 member firms servicing the market (Sturgess, 2010). The commodity derivative facilitates physical deliveries required to complete futures contracts.

The commodity of interest for this research is white maize which is processed into maize meal. However, owing to the white maize substitution effect with yellow maize, their relationships are discussed in relation to spot price. Figure 4 below shows this relationship and it is clear from the figure that prices of both white and yellow maize move together over time. Co-movement of prices can be attributed to the same production system, harvesting, marketing period and the fact that there is a substitution effect between the two commodities. Although the prices move together, it appears that yellow maize is a bit more expensive, as compared with white maize. This can be attributed to its shortages, as almost every year there are imports of yellow maize.

The spot prices of both white and yellow maize were not very high between 2007 and 2009 (see Figure 4 below). However, between the period of March 2010 and September 2010, prices of both commodities were lower and thereafter prices picked up to around R2 900,00 per ton. The prices dropped a little and then picked even higher between November 2013 and March 2014. The reasons for these high price increases can be attributed to a severe drought in the US and also local shortages for a period of time that pushed the local market to import parity levels. In fact, it is worth noting that the industry recorded the highest maize price in history for a few trading days of about R3 800,00 per ton for yellow maize in March 2014 when a squeeze occurred in the future market. This was just a technical price for a short period of time and no maize was actually imported at that level.
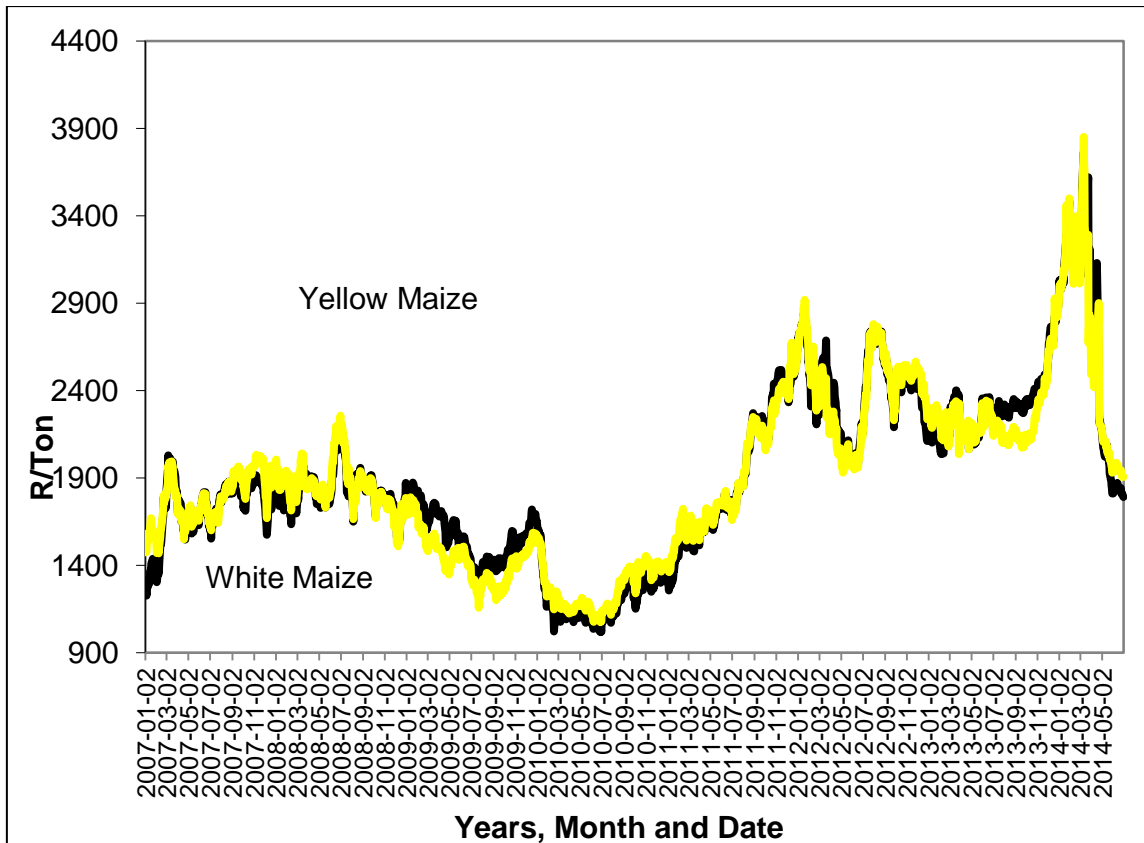
Figure 4: Spot price for white and yellow maize

Source: SAFEX, 2014

3.7 Maize utilisation

Two types of maize are produced in South Africa, namely yellow and white maize, as mentioned above. White maize is mainly used for human consumption and yellow maize is mainly used as feed for livestock (DAFF, 2012). Although white maize is mainly used for human consumption, there is a small proportion of white maize that is used annually for animal feed. Human consumption of yellow maize is also available in lesser quantities (SAGIS, 2014). In terms of monthly usage, it appears that white maize is used increasingly between January and August (see Figure 5 below). It is only between August and December that the utilisation of yellow maize increases.

The trend confirms the DAFF (2012) analysis that white maize is used more for human consumption than yellow maize. Furthermore, the trends suggest the substitution of white maize with yellow maize during the period when there is less stock and this could be the period when maize is still being planted and is

expected to enter the market. Utilisation of maize includes maize for gristing purposes, although very fewer quantities of maize are used as grist (SAGIS, 2014).

The long-term projection in the maize industry is that lower white maize plantings are anticipated. Despite the lower white maize plantings projected over a long term, South Africa is expected to remain a net exporter of white maize as reduced plantings are anticipated to be largely offset by improved yields (BFAP, 2014). Domestic human consumption of white maize is expected to remain relatively constant and any significant growth in white maize production will be absorbed by the export market, or alternatively will have to substitute yellow maize in the feed market at a discounted price (BFAP, 2014). Yellow maize plantings are anticipated to increase at the expense of white maize in the long term. This can be attributed to continual increases in demand for chicken meat as compared to all other meat products. More yellow maize will therefore be required by the poultry industry as the main input in the preparation of chicken feed.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
White	440 0	472 0	495 0	475 0	452 8	402 9	456 2	414 9	364 7	399 9	408 3	381 8
Yellow	349 0	262 0	290 0	358 0	399 9	372 4	382 0	401 9	469 6	512 0	472 2	404 5
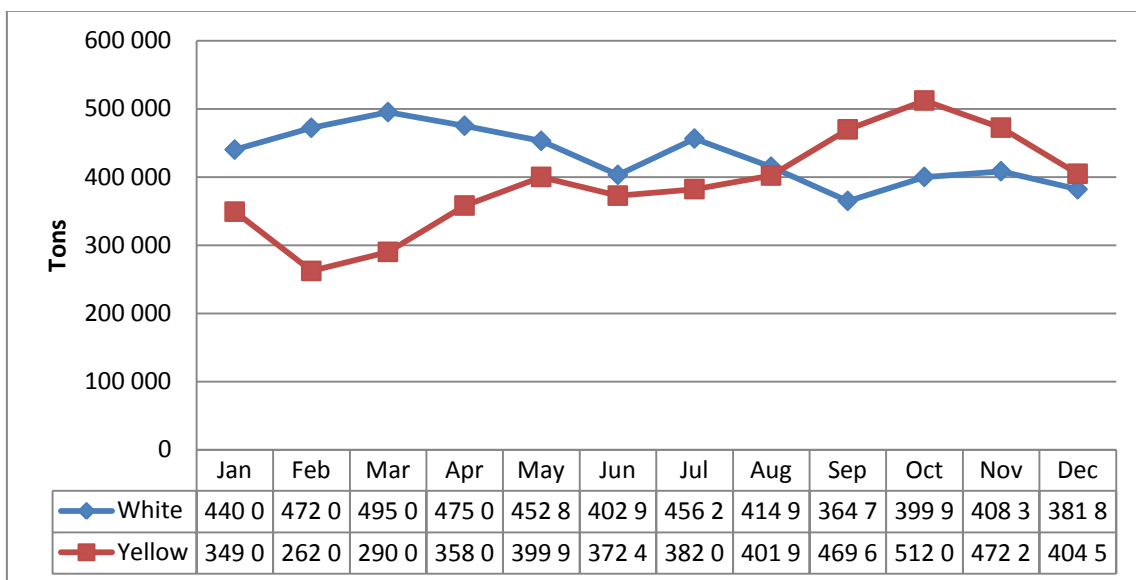
Figure 5: Utilisation of white and yellow maize
Source: SAGIS, 2014

3.8 The South African maize supply chain

Maize meal is derived from maize seed and therefore it is important to understand the various stages and processes that occur up until maize meal is realised and purchased by the consumers in the market place. The maize supply chain is presented in Figure 6 below. As depicted in the figure, the maize supply chain consists of various role players. From top down, the supply chain commences with research and biotechnology institutions which are responsible for development of varieties that are planted in different production regions.

The supply chain can be divided into three categories, namely primary, secondary and tertiary levels. At the primary level are the inputs suppliers, such as farmers and silo owners. Inputs suppliers are those companies that supply growers with inputs. For example, seed, fertiliser, chemicals, fuel, mechanisation and credit are some of the inputs needed for the production of maize. Farmers/producers purchase seed and plant the maize which is later harvested and delivered as stocks to the silo owners. A silo owner performs functions such as grading and storage of grain until it is required for trading or for processing. All role players mentioned add value to the maize crop as it leaves their premises or places of distribution, thus creating a value chain business.

The secondary stage is where the processing of maize is conducted by various role players, such as millers, the animal feed industry, and other processors. Millers process mainly white maize into maize meal which is used for human consumption. On the other hand, animal feed manufacturers process mostly yellow maize which is used for feeding livestock, especially for layer rations and for broiler feeding. Yellow maize constitutes a small portion of the total feedlot requirement (NAMC, 2004), and this is because yellow maize is often more expensive than white maize. Therefore, white maize waste (hominy chop) is often used as a substitute for yellow maize in animal feedlots. This reduces the cost of purchasing feed in the animal industry.

The tertiary sector mainly involves trade in maize and maize meal products. It consists of traders and transporters, importers and exporters, wholesalers and

the retailing industry. Many supermarkets that sell maize, either as super or special maize meal in the urban and rural markets, purchase their products from processing firms or from wholesalers. It is through these sales that traders/business entities are able to determine the price of the 2.5 kg maize meal package and then sell the product to the consumers.
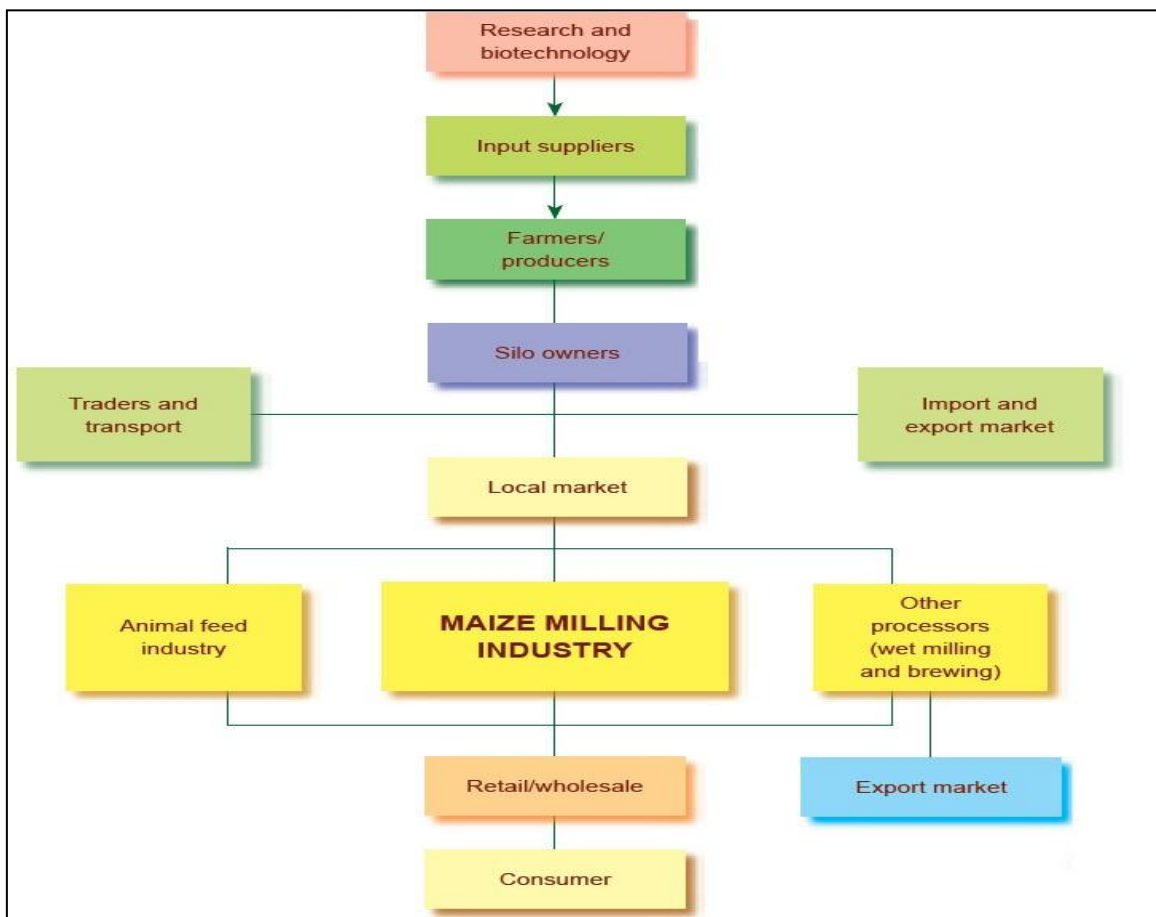
Figure 6: The South African maize supply chain

Source: Maize Tariff Working Group, 2005.

In the section that follows, detailed analysis of maize processing, export and import are provided.

3.8.1   Maize processing

Maize is mainly processed for human consumption and for animal feeding. Analysis shows that there is an increasing trend in the processing of both yellow and white maize (see Figure 7 below). This provides an indication of the industry growth. In the 2000/01 processing year, between 3 million tons of

yellow maize and 3.5 million tons of white maize were processed, but during 20011/12, about 4 million tons of yellow and 4.5 million tons of white maize were processed. Comparatively, there is an increase in the processing of white maize, rather than in the processing of yellow maize. This might be attributed to the fact that white maize, although mainly used for human consumption, can serve as a substitute for yellow maize in the animal feedlot through the hominy chop by-product.

Analysis shows that, on average over the last 12 years, about 4 million tons of white maize and 3.8 million tons of yellow maize were processed. The trend as shown in Figure 7 below is relatively flat, denoting less fluctuation in the quantities of maize processed and this could be attributed to the high prices of maize (less demand) in the previous years and slow economic growth. The figure further shows that there was only one jump in white maize in 2007/08. Otherwise, white maize is relatively flat and yellow maize is growing over time. According to a GAIN report (2013), South Africa's economic growth was expected to grow by less than 3 % in the 2013/14 financial year. This slow economic growth is attributed to factors, such as labour demonstration, uncertainty in financial markets and slow economic recovery after depression, and will continue to affect maize industry processing.
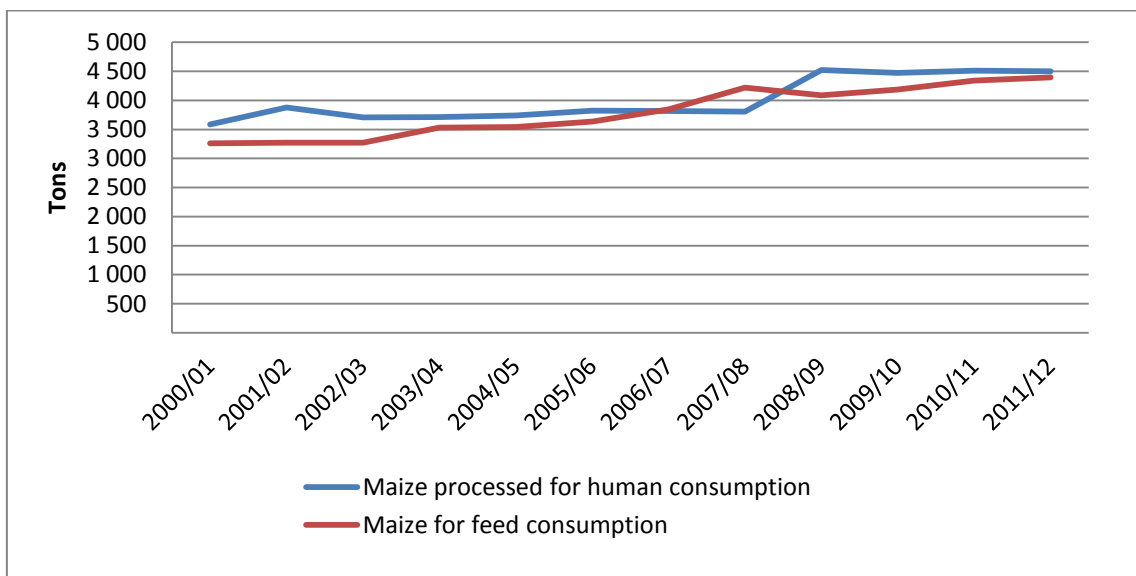
Figure 7: Trends in maize processing

Source: DAFF, 2013

Further analysis of maize industry processing has revealed that, of the total volume of white maize processed, approximately 83 % is used for human consumption, 16 % is used for animal feed, and 1 % is used for gristing, as shown in Figure 8 below.
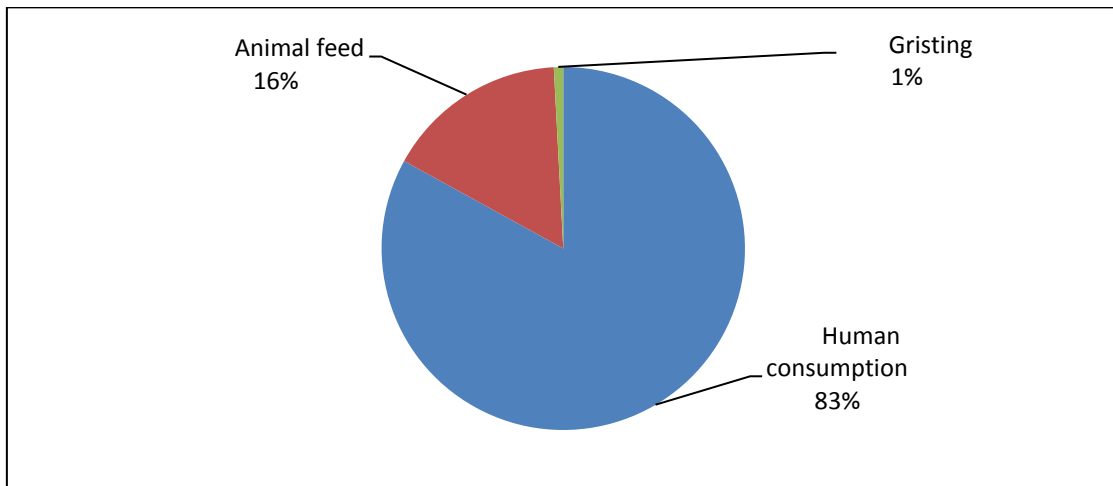
Figure 8: Share in the white maize processing
Source: SAGIS, 2014

Analysis of yellow maize processing reveals that about 90 % of yellow maize is processed as animal feed, 9.9 % is processed for human consumption (brewing of beer) and 0.1 % is processed as gristing (see Figure 9 below). This leads to the conclusion that white maize is mainly used for human consumption and that yellow maize is mainly used as an input into the animal feed industry. However, during periods of drought and shortages in maize production, yellow maize can be used for human consumption.
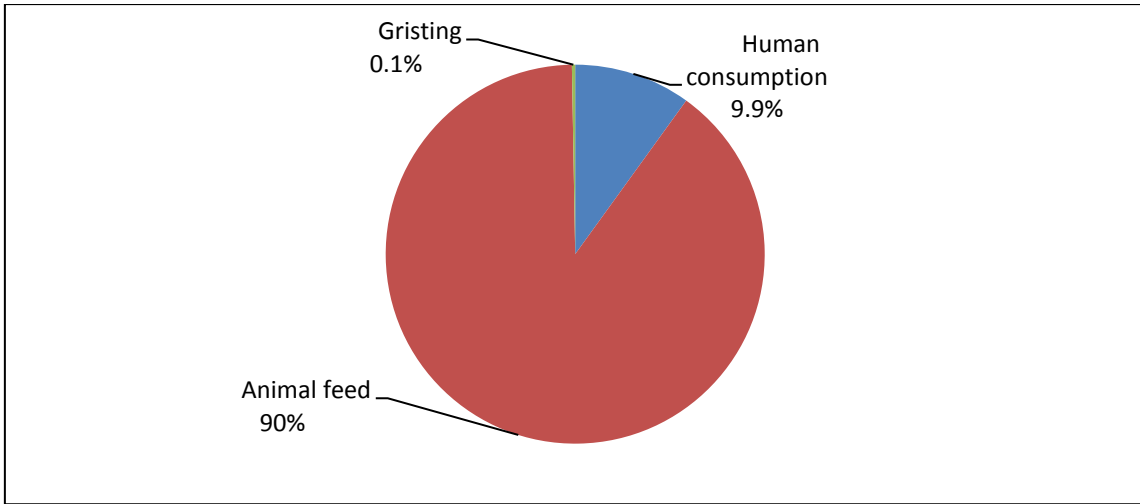
Figure 9: Share in the yellow maize processing

Source: SAGIS, 2014

3.8.2 Exports of maize

The South African maize industry is an important earner of foreign revenue through exchange rate. This happens through the export of maize and maize products to the world markets. Maize is mainly exported to the following countries: Taiwan, Japan, Mexico, Zimbabwe, Italy, Egypt, Mozambique, Botswana, Namibia, Swaziland and Lesotho (WTA, 2014). Figure 10 below presents the export volumes of yellow and white maize to the world markets.
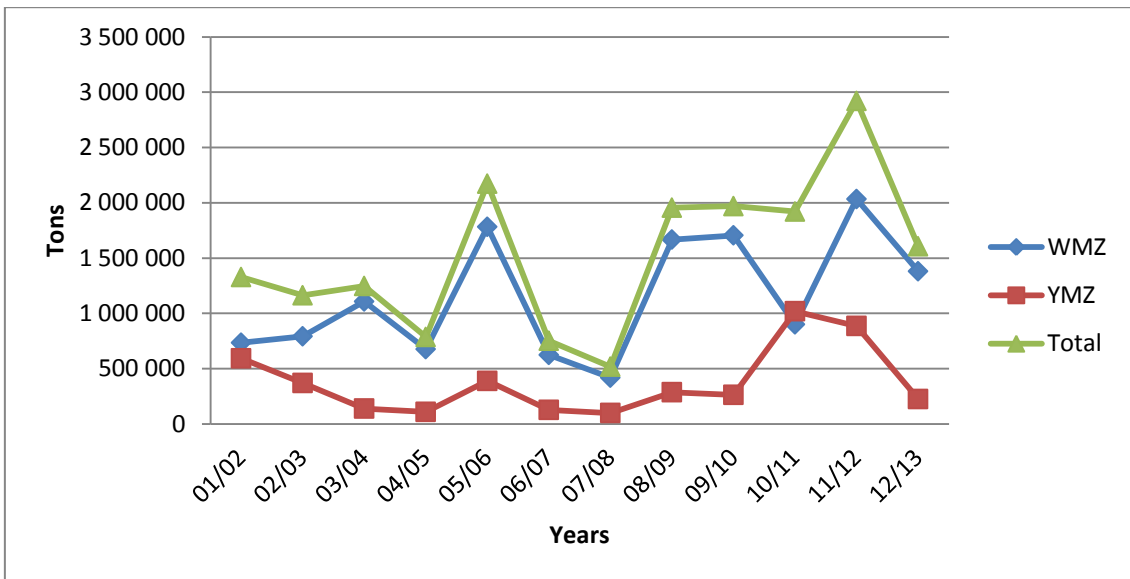
Figure 10: Export of white and yellow maize

Source: SAGIS, 2014

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Analysis shows that white maize is being increasingly exported to world markets, as compared with yellow maize. However, it was established that white maize is mostly exported to African countries. This can be attributed to an increase in consumption of maize by the African population. However, over the last five years there has been structural shift in the region with respect to production and marketing of maize. Surplus production out of Zambia and Malawi has started feeding into South Africa's traditional markets (BFAP, 2014). This can be attributed to the fact that South Africa produces GM maize and Zambia produces non-GM maize. This trade activity implies that some consumers in the African market prefer non-GM white maize. However, it has been established by BFAP (2014) that African countries do not consistently apply their policies that restrict the importation of non-GM white maize into their countries. For example, Zimbabwe imported non-GM white maize produced in Zambia in 2011 and 2012 production seasons in application of their policies. Surprisingly, in 2013 when the Zambian government imposed restrictions on maize due to shrinking maize stocks, Zimbabwe turned back to South Africa to supplement white stock levels in the country (BFAP, 2014).

Maize is the staple food for majority of Africans, accounting for approximately 94 % (DAFF, 2012). There was a significant increase in the export of white maize during the 2005/06 production year as shown in Figure 10 above. This increase was influenced by the industry surplus production which also led to an increase in the export of yellow maize. During the 2010/11 production season, the industry experienced a drop in the export of white maize, whereas a significant increase in yellow maize exports was recorded, in spite of production increases in both commodities. This led to equal volumes being exported to world markets. This situation can be attributed to changes in market conditions, which might have come with price increase in yellow maize.

Still on the issue of yellow maize development, it was found that ever since the visit by the Japanese and Taiwanese delegations to South Africa in 2013, the maize industry has experienced increases in exports of yellow maize. Japan

has already imported 119 495 tons, and Taiwanese has imported approximately 76 226 tons, of yellow maize (Grain SA, 2013).

3.8.3   Imports of maize

The South African industry produces enough white maize to feed the nation. Therefore, there is little to no imports of white maize in certain production years. For example, on average in the last 12 years of production, the industry has imported approximately 45 000 tons of white maize, while in many years of production there were no imports.

With regard to yellow maize imports, there is continual annual volume that is imported from the world markets, although not a significant amount. On average over the last 12 years of production, the industry imported about 361 000 tons of yellow maize (SAGIS, 2014). Yellow maize is used to feed livestock, especially poultry, hence during times of shortages the industry imports maize from world markets. During the 2012/13 production year, South Africa imported maize mainly from Brazil, Argentina, Swaziland, Belgium and the USA (WTA, 2014). However, the volume imported from world markets was insignificant.

3.9   Retailing sector

Retailers are the most important outlets that sell maize meal and other maize products in South Africa. Retailers are mostly found in urban markets, and in rural areas, supermarkets and general dealers are encountered. With these different marketing outlets, it is important to provide an overview of the retailing environment as it is the place where most of the maize meal and maize by-products are sold.

The South African retailing industry is on the rise and this is supported by the increase in retail space and in the number of shopping centres (Gauteng Treasury, 2012). These indications suggest that South Africa is experiencing a continual boom in shopping centres, and some townships might have benefited from these increases. The drive behind increases in retail space and the establishment of new shopping centres can be attributed to global and domestic economic indicators. These include the levels of interest rates, inflation and

foreign exchange rates. Expansion in the food value chain and shops can also be attributed to the improvement of household income levels and disposable income and the continual increase in urbanisation.

3.9.1 Key food retailers in South Africa

There are four key industry retailers that sell food and non-food items in South Africa, namely Shoprite Checkers, Pick n Pay, SPAR and Woolworths. Shoprite Checkers and Pick n Pay have 30 % of the market share (see Table 1 below). Although Pick n Pay and Shoprite Checkers have equal market shares, it appears that Shoprite Checkers has more stores (1 303) than Pick n Pay does. This makes Shoprite Checkers the leading retail outlet in South Africa. The market shares of SPAR, Woolworths and Massmart are 26 %, 11 % and 1 %, respectively. Given these market shares of the food industry retailers, it can be said that the South African food retailers have a concentration of ownership and operate as an oligopoly, where the action of one retailer leads to action change by the other retailers. The impact of the retailers' behaviours in the food value chain environment may lead to decreases or increases in prices of maize meal. These impacts are explored and discussed in the section that follows.

Table 1: Market share of the major food value chain stores

Outlets	Market share	Stores in SA
Shoprite Checkers	30%	1303
Pick n Pay	30%	794
SPAR	26%	800
Woolworth	11%	440
Massmart	1%	265
Others	2%	-----

Source: Gauteng Treasury, 2012

3.10 The role of rural markets and their relation with urban markets

Rural food markets play an important role in South Africa. The role of rural markets (for example super markets and general dealers) is seen through creation of job opportunities for rural dwellers when food is purchased. Rural shops encourage communities to shop local and to improve local business to better meet people's needs (McCray, 2011). Rural food markets are also

important through bringing different agricultural products closer to the communities at a price. In the competitive market economy, price of a product is determined by the market forces of demand and supply. Although price is determined by market forces it is important to know if there is a linkage between urban and rural markets prices. This is because price increase or decrease in urban markets should have an impact on rural food markets were rural household purchase the products.

Maize meal is considered to be a food security product in South Africa and its affordability is a concern for rural development. According to the NAMC (2003) food prices in rural areas are generally higher than in urban areas. Rural food markets in SA charges different prices on their maize meal products (for example 2.5kg, 10kg and 50kg). Price differencing by rural shops is ideal for their existence. However, excessive pricing on the product can have a negative implication towards household's food affordability and security as many rural households purchase their maize meal product(s) from rural shops.

3.11   Maize meal price trend

Figure 11 below presents the average maize meal price trend in South Africa for the period of November 2006 to July 2012. As depicted in the figure, the price of 2.5 kg super maize meal continued to increase, with markedly lower price variations. An upward trend in the price of maize meal is observed, which trend is consist with the general increase (caused by inflation) in the price of goods and services in South Africa over the same period. South African maize is traded on SAFEX, which is linked to world market dynamics. Over the same period, commencing in late 2006, international and domestic markets experienced higher food prices.

Although there was a decline in 2009, such decline seems not to have been fully effected into local markets, as the prices continued to increase. According to FAO (2010), a high record of food prices was experienced during the world food crisis; this was followed by an increase (surge) in food prices during the 2010 production season. Increases in the food price are attributed to droughts in the main grain production regions and rising oil prices, which further led to an

increase in the price of inputs and the reduction of stockpiles and a major driver in food inflation is also the exchange rate. Depreciation in the exchange rate causes food prices to increase.
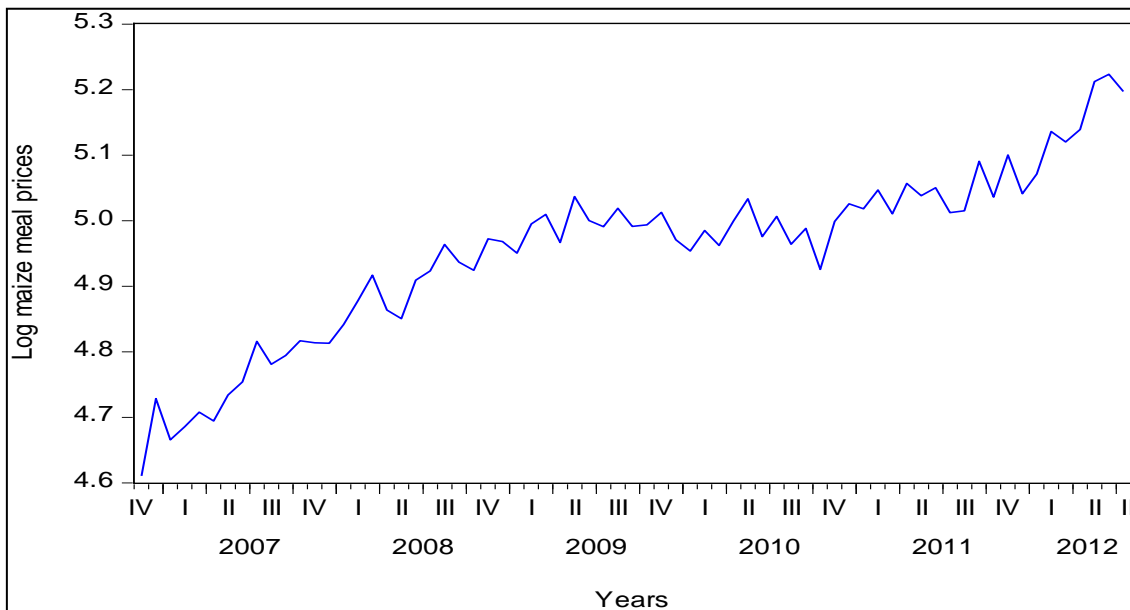
Figure 11: Average time series plot for 2.5kg super maize meal in South Africa

3.12   Price levels between market locations

Price is the integrating force between market levels (Tomek & Robinson, 1995). This means that if the supply of a product increases relative to the demand, retail prices will drop and consumers will benefit from lower prices. Table 2 below provides descriptive statistics for 2.5 kg maize meal at various market locations. On average between November 2006 and July 2012, the price of 2.5 kg maize meal was lower in the Free State (FS) province (R13,00), followed by the North West (NW), with a price of R13,45. Other provinces with lower prices were the Western Cape and Northern Cape. Urban prices, on average, were R13,98, and Gauteng province had an average price of R14,02.

Although the assumption is that of a central price-making mechanism, it is not surprising to see the Free State and the North West having lower prices for 2.5 kg maize meal. According to DAFF (2012), Free State province accounts for 39 % of the commercial maize produced in South Africa and the North West produces about 23 %. The summary statistics further show that prices are also lower in urban markets (R13,98). For example, Gauteng produces

approximately 5 % of the total maize in South Africa (DAFF, 2012) and prices in Gauteng province (GP) are not higher. This could be attributed to the processing facilities that are located near the urban markets and cities.

Maize meal appears to be very expensive in Limpopo province (LP), the average price was R16,09 over the period from November 2006 to July 2012. Factors that drive higher prices for maize meal in regions include fuel prices, distances between market locations, behaviour of some market agents, and shortages of the product. For example, Limpopo produces about 2 % of the total commercial maize production in South Africa and its location is relatively far from the main processing regions. The likelihood is that prices might be higher in areas where there is a lack of production and processing facilities.

According to DAFF (2012), Mpumalanga (MP) produces 21 % of the total commercial maize crop in South Africa. The majority of maize produced in the province (MP) is yellow maize which is mainly destined for animal industries to be processed as feed. Therefore, it is not astonishing to find high prices of 2.5kg white maize meal in Mpumalanga (MP). High prices of white maize meal can be attributed to industry shortages and to structural factors. The maximum price for 2.5 kg maize meal was found to be R27,00 in MP, R24,00 in LP, R21,40 in KZN and R20,36 in NW.

Table 2: Descriptive statistics of 2.5kg super maize meal prices

Variables	Mean	Std deviation	Min	Max
SA	13.98725	1.602311	10.24	17.78
EC	14.53899	2.273537	10.4	18.96
FS	13.0029	1.463631	9.86	16.8
MP	15.35667	3.561349	9.38	27.00
GP	14.01942	2.179292	8.00	19.50
LP	16.09638	3.19061	10.88	24.00
WC	13.81188	2.135109	8.03	17.69
NW	13.45551	1.501071	9.84	20.36
KZN	14.5871	2.732229	7.82	21.40
NC	13.88188	1.661006	10.28	18.17

Data source: NAMC, Stats SA, 2006-2012

3.13   Urban and rural food markets price relationship

In this section the price relationship between urban and rural food markets is analysed. The purpose was to determine whether there is a statistically significant difference between urban and rural food market mean prices. A simple price estimate was constructed to measure the relationship between variables. Natural logs were applied to time series data to remove the multiplicative factor so that results could be presented in a linear form. The results are presented in Table 3 below.

Table 3: Relationship between SA and rural food markets

Variables (Logs)	Coefficient	Std Err	T stats	Adj R^2
SA-EC	1.01286*	0.003542	285.9352	0.766745
SA-NC	0.99677*	0.002623	380.0715	0.774542
SA-WC	0.99322*	0.003982	249.4523	0.72753
SA –FS	0.97215*	0.002560	379.7133	0.759610
SA –KZN	1.01251*	0.004853	208.6552	0.698130
SA-MP	1.02898*	0.007555	136.1994	0.455461
SA-NW	0.98472*	0.004680	210.4189	0.051018
SA-LP	1.04929*	0.62615	191.5631	0.626159
SA-GP	0.99850*	0.005381	185.5740	0.492780

Single asterisks* denotes significant at α= 0.01.

The test results show that urban markets have a positive linear relationship with rural markets. A hypothesis test was conducted to ascertain if there is a statistically significant difference between urban and rural food market mean prices in South Africa. The investigations reveal that there is a statistically significant difference between urban and rural markets mean prices, and this was found to be at a 0.01 level of significance. The coefficients between urban and rural markets were found to be above 80 %, denoting very high price differences between market locations.

For example, the relationship between the urban market price and the price of maize meal in the Eastern Cape is more than 101 %. This can be interpreted as follows: ceteris paribus, a 1 % increase in the price of 2.5 kg maize meal in the

urban markets, on average, led to a 101 % increase in the price of maize meal in the Eastern Cape. It is important to note that this interpretation is based on elasticity's and not on the total value of the product. In comparative rand terms, on average, a unit increase in the price of maize meal in the urban market led to R1.01 increase in the price of 2.5k g maize meal in the Eastern Cape rural markets.

The average price differences between urban and rural food markets are very much higher in KZN, LP, MP, WC, and EC, respectively. This finding relates to the work on economics of geography by Krugman (1991). According to Krugman (1991), manufacturing in general might end up concentrated in one or few regions of the countries with the remaining regions playing the peripheral role of agricultural suppliers to the manufacturing core. This might not differ from many of the South African provinces that produce raw maize in the rural spaces to supply processing firms closer to the cities or urban markets to produce maize meal. Many provinces seem to be acting as suppliers of raw maize and when processing is complete maize meal is taken to the provinces at higher prices.

Higher price differences between market locations might be as a result of transactions and transfer costs. Other important factors responsible for significant price differences between market locations can be attributed to lack of value adding facilities (processing), storage, poor roads and distances between markets, communication systems and actions of traders which are part of the structural and market related factors not analysed in this study but require further research.

In conclusion, estimation was also made of the relationship between aggregated urban and aggregated rural markets. The results show a statistically significant difference between urban and rural food markets in mean price. The coefficient of the price relationship was found to be 1.008 at the significant level of 0.01. On average, this means that rural food market prices of 2.5 kg super maize meal are more expensive than urban market prices.

3.14   Price variability

Higher and lower price variability creates problems in spatial markets and has undesired consequences (Pindyck, 2004). Irregular price patterns are common in spatial markets and affect both consumers and suppliers. The patterns cannot be easily observed or explained, given entries for the period under investigations. In order to provide inferences about price variability, the Co-efficient of Variations (CV) is computed. Table 4 below shows the computation of CV and its relationship between spatial markets. The analysis shows that the coefficient of variation is very high in MP, approximately 23 %, followed by LP with a CV of approximately 20 %, and KZN with a CV of approximately 18 %. EC, GP and WC each have a CV of about 16 %. Spatial markets with a lower CV are NW, FS, NC and SA.

The analysis revealed that provinces with high productions of maize have less price variability in the maize meal product. The implication is that consumers and traders in the market locations that have lower price variability will tend to have a better planning of their incomes and budgets, compared with provinces which have high price variability. However, it should be noted that the lower price variability in the NC is not linked to production of maize, but to a lower consumption of the product. As for the urban market (SA), the variability is lower simply owing to locations of the markets and the availability of good infrastructure.

Consistent with the price relationships findings, MP rural markets were found to have a high price variability of 23 %, this is attributed to less production of white maize in the province. More yellow maize is produced in MP than white maize, but unfortunately it (yellow maize) is mainly used in the animal feed industries, hence the prices of white maize in MP were found to be higher due to shortages. The implication of high price volatility between market locations signifies various problems of spatial markets and cannot only be linked to product shortages or to lack of processing facilities. To the consumers, the problems of product affordability might occur, while to the producers, margin values of production and storage facilities will be affected. Lower price volatility can relate to maize distribution by the market agents in spatial markets. The

marginal value of product distribution can be negatively affected and as a consequence the product might not be available in the markets where it is mostly needed and this will result in an expensive product.

Table 4: Price variability

Markets	Mean	SD	CV
EC	14.538	2.274	15.640
LP	16.096	3.191	19.822
FS	13.003	1.463	11.255
GP	14.019	2.179	15.545
KZN	14.586	2.732	18.731
MP	15.355	3.560	23.186
NW	13.455	1.501	11.156
NC	13.882	1.661	11.962
WC	13.810	2.134	15.453
SA	13.988	1.602	11.453

Source: NAMC, Stats SA, Author's computation

3.15   Summary and conclusion

This chapter has provided an overview of the maize industry value chain. Two types of maize are produced in South Africa, namely yellow and white maize. White maize is mainly used for human consumption and yellow maize is mainly used as feed for livestock (DAFF, 2012). Maize is processed into maize meal by various agro-processing firms and is later sold to different markets. The main food value chain stores that sell maize meal in South Africa are Pick n Pay, Shoprite Checkers, SPAR and other supermarkets. Maize meal is also sold by a number of rural shops or supermarkets.

Market analysis of monthly price information focusing on price trends, price levels and relationship, and variability revealed the following.

- On aggregate, an upward trend in the price of maize meal was observed for the period from November 2006 to July 2012. The trend was found to be consistent with that of the general price of goods and services in South Africa.

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- The price of 2.5 kg maize meal was found to be lower in maize producing provinces, such as FS and NW. Other provinces that showed a lower price level of white maize meal were the NC and WC. The lower price of maize meal in NC and WC was not attributable to the production potential of the areas, but rather to lower consumption. It was also found that in areas where white maize is not much produced, for example SA and GP, the prices of maize meal were not high. This can be attributed to good infrastructure, such as processing facilities which are located near cities, tarred roads, communication, and distances to the market which are shorter.

- All the coefficients in the price relationships were found to be higher than 80 %, denoting higher price increases. A statistically significant price difference was found between all the markets estimated. This was found to be statistically significant at 0.01 levels. Estimation further revealed a statistically significant price difference between aggregated urban and aggregated rural food markets. The coefficient of the price relationships was found to be 1.008 and statistically significant at 0.01 levels. This meant that, on aggregate, prices of 2.5 kg maize meal were significantly higher in rural food markets.

- Price variability computation has revealed that provinces with lower maize productions have a high price variability of the maize meal. The results also show that SA (urban market) and NC have lower price variability. This can be attributed to the availability of infrastructure in SA, but in the NC the attribution is to the lower consumption of the product. It was established that MP rural markets have high price variability. MP produces more yellow maize which is destined for animal industries than white maize. The high price of maize meal in MP can be attributed to shortages of the product, marketing agent behaviour and to other problems of spatial markets.

CHAPTER 4: RESEARCH METHODS

4.1 Introduction

This chapter provides an overview of the research methodology used in the measurement of spatial market integration between urban and rural food markets. The chapter outlines the sampling method used in the study in section 4.2, and the data collection and institutions involved are explained in section 4.3. Section 4.4 discusses the background on food price collection points. Section 4.5 details the data analysis techniques and methods used in the study. Weaknesses of the methodologies employed are explained in section 4.6. The analysis tool used in the study is explained in section 4.7. The chapter ends with the summary and conclusions in section 4.8.

4.2 Sampling method

The primary objective of this research is to measure spatial market integration between urban and rural food markets. The sampling method used to select markets for the survey study was based on randomness. In the selection process, only one rural food market/shop was selected from each Local Municipality (LM) in a District. This translated into, for example, 4 and 5 rural food markets in each District Municipality. Food markets in the LM were those that did not use scanners in the recording of food prices. In the urban food markets, scanners were used to record food prices.

There were many products with different prices in the urban and rural food markets under FPM process by the NAMC and Stats SA. However, a choice needed to be made among the products to establish if market integration exists. The 2.5kg super maize meal package was selected for the study. The rationale behind the choice of 2.5 kg maize meal being selected for the survey from all the other products was based on the availability, uniformity of the product weight (kg) which was found to be common in all the South African provinces, and on trends that the product displayed. Maize is one of the food security crops in South Africa (DAFF, 2012). With this state of affairs, it became interesting to investigate the maize meal price integration between market locations.

4.3 Data collection

This research used monthly time series price data, which was collected from the period of November 2006 to July 2012, in order to measure spatial market integration. Data was collected by the NAMC, in collaboration with Stats SA. The data was collected from urban and rural food markets, as shown in Figure 12 below. Rural food markets were represented by data collected from a total of 183 outlets, and urban market prices data was collected from all South African retailers. Urban markets time series price data included the metropolitan areas and are sometimes referred in this study as the "central markets".

In the collection of food price data, a sequence of random variables indexed by time was realised, which led to a total of 69 observations (sample size). Although there were many products among the monthly food price monitoring collection, super maize meal was found to be interesting owing to trends that the data displayed. It is out of these trends that more information is drawn to generate analysis and to present results of the interaction between urban and rural food markets. This study concentrated on the analysis of maize product, particularly the 2.5 kg super maize meal package, as explained above. Transaction costs form an important part of food pricing, so that relationship can be drawn. It would have been helpful to collect such information as part of the FPM monitoring process separately from the product prices. Unfortunately, data on transaction costs did not form part of the FPM collection.
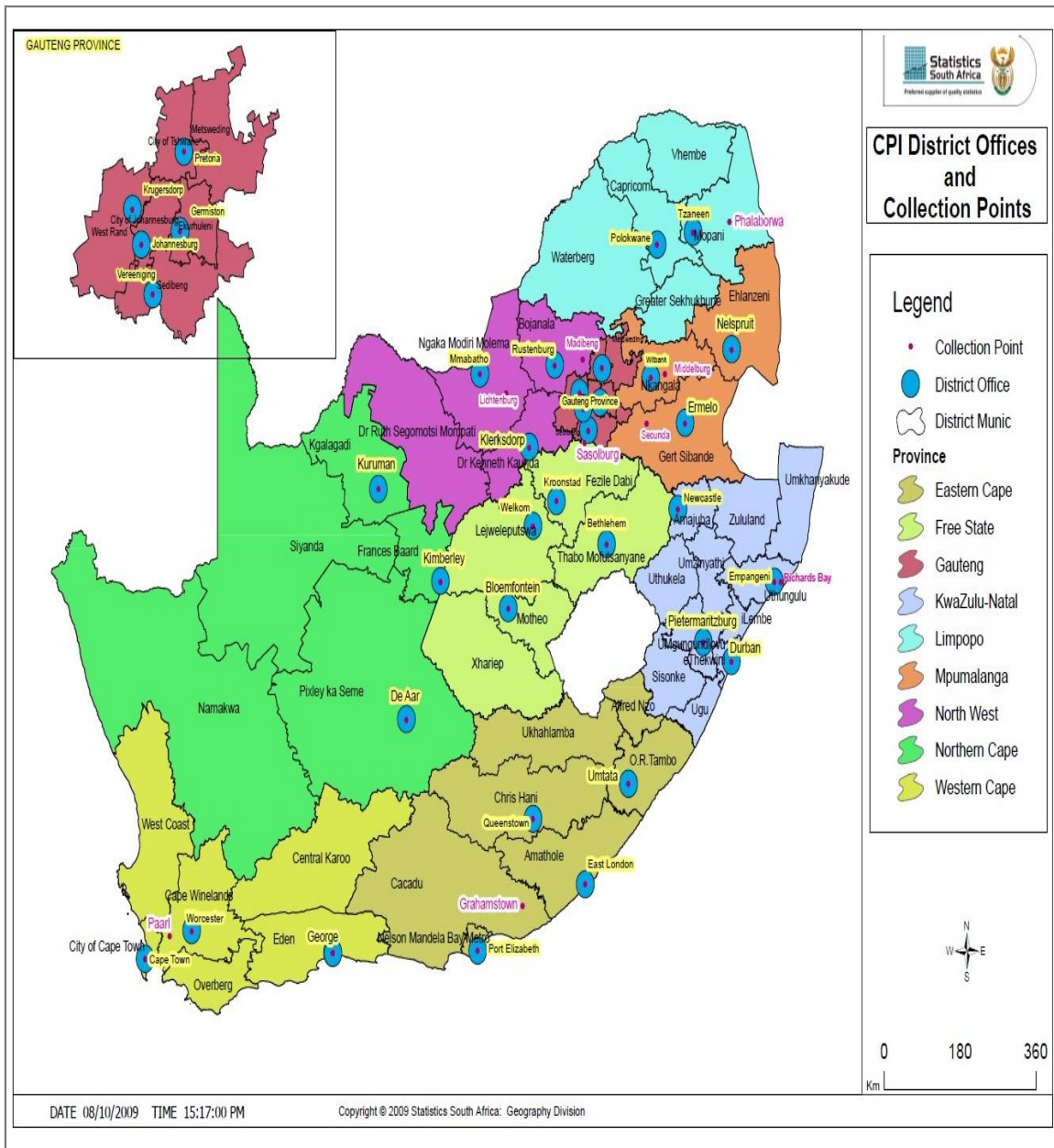
Figure 12: FPM collection points

Source: Stats SA

4.4 Background on food price collection points

Provinces, towns and local municipalities were urban and rural food prices data was collected are shown in Figure 12. The study covered the entire country, for example 29 food outlets were covered in the Free state, 17 in the Eastern Cape, 16 in Mpumalanga, 16 in Gauteng, 21 in Limpopo, 24 in North West, 27 in KwaZulu-Natal, 14 in the Northern Cape and 19 in the Western Cape. In total, prices of 26 food items were monitored at 183 rural outlets as mentioned above. Concentration of monthly food price collection for urban markets was in major

towns which are mostly developed in terms of infrastructure (such as roads, electricity, and water and communication systems). Access to the urban food outlets was not a challenge to the food price collectors.

With respect to the collection of rural food price data in the local municipalities, the decision implemented was to have one food outlet per local municipality. The study therefore involved collection of price data in many local municipalities which differs in terms of infrastructural development and economic activities. For example, in the local municipalities of the EC, KZN, LP MP, NC and NW there is still serious problems of infrastructure, particularly roads and running water which impact negatively of the rural households livelihoods. Although concentration of the rural food outlets were on supermarkets and general dealers, many food price collectors in the EC, KZN MP, LP and NW reported serious problem of access to the rural food outlets mainly due to distances and poor roads.

4.5   Data analysis

Empirical analysis on time series data often assumes that the underlying time series is stationary (Gujarati & Porter, 2009). In order to proceed with an econometrics analysis of time series data, the first step is to check whether each series is stationary or non-stationary. This is because regression of non-stationary time series data will lead to problems of autocorrelation, high R^2 even when there is no meaningful relationship between variables and questionable forecasting (Gujarati & Porter, 2009).

The procedure is to perform pre-tests of stationary before other econometric analysis. Gujarati and Porter (2009) define stationary time series as a time series that its mean, variance and covariance at various lags are supposed not to change over time. Accordingly, a stationary series will have a mean reversion or will not drift too far away from the mean and the revision depends on the auto-covariance.

Stationary time series is based on the Data Generation process (DGP). This means that the parameters do not exhibit increasing or decreasing patterns. On

the other hand, a non-stationary series has a random walk effect, which means the mean is constant but with changing variance over time. Time series data which is not stationary requires transformation. There are three steps to detect whether a series is stationary, namely, Graphical analysis, Auto Correlation Function (ACF) and Correlogram, and lastly through unit root test. The first two methods of analysis act as informal analysis and the latter is referred to as a formal method. Informal and formal methods of data analysis are described in the section that follows.

4.5.1   Graphical analysis

The first step to detect whether time series data is stationary or non-stationary is to plot a graph. According to Gujarati and Porter (2009), visual plotting provides an indication of the nature of time series. In most cases, an upward trend might be observed on a plotted graph. When this happens, it might suggest that the mean is changing and therefore the series can be declared non-stationary. A graph can also exhibit price variability, which is common in most time series data. The other component that the graph can indicate is seasonal variation. Seasonality is common among agricultural commodities. Maize, for example, is a major variable input in the production of maize meal and therefore its shortage or surplus might lead to fluctuation in the availability of maize meal. Although graphical analysis is not a remedy to non-stationary data, it provides an indication of a unit root presence.

4.5.2   Auto Correlation Function and Correlogram

The Auto Correlation Function (ACF) is another informal method for testing if time series is stationary. If the estimated ACF is plotted against lags, a sample correlogram will be realised. The output results of a sample correlogram can be obtained after having employed statistical packages, such as Eviews or STATA. Through the use of sample autocorrelation, the series becomes stationary if autocorrelation at various lags hovers around the zero axis (solid vertical line). Non-stationary series occur when the autocorrelation coefficients at various lags are very high and decline very slow as the lags lengthen (Gujarati & Porter, 2009: 751).

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The use of Correlogram employs autocorrelation (AC), partial autocorrelation (PAC), Q statistics and the probability value. The Q statistics test the null hypothesis that all AC up to lag k is equal to zero. When Prob >Q Stat, then it suggests a significant autocorrelation. This mean probability value is less than 5 % significant level. Therefore, the null hypothesis that all the lags are not autocorrelated is rejected. This means AC value at lag 1 is very high and declines slowly with the increases of the lags. When this occurs, it can be concluded that the time series has a unit root or is non-stationary.

4.5.3   Unit root test

Unit root testing is regarded as the formal test of stationary time series (Wooldridge, 2013: p 613). Therefore, it is important to define what a unit root means. The term 'unit root' refers to the root of polynomial in the lag operator (Gujarati & Porter, 2009: 744). A variable which contains a unit root is denoted by I (1). Use of time series price data characterised by the unit root or random walk can lead to serious errors and ultimately estimation problems. The equation 1 below shows the relationship between current and previous prices in the demonstration of a unit root.

$$\mathrm{P}_t = \mathrm{P}_{t-1} + \mu_t \qquad\qquad\qquad (1)$$

In terms of series integration orders, equation 1 is of the order I (1), the equation is non-stationary. However, differentiating equation 1 only once can lead to stationary series and when that occurs the equation is denoted by I (0). The equivalent of equation 1 is stated in equation 2 below, with the co-efficient of the lagged prices.

$$\mathrm{P}_t = \rho \mathrm{P}_{t-1} + \mu_t \qquad\qquad\qquad (2)$$

In equation 2, P_t and P_{t-1} represent prices of maize meal at time t, and $t-1$ is the lagged price of maize meal. The co-efficient of ρ represents the lagged price and μ_t is the error term and is independently and identically distributed (i.i.d) with zero mean and finite variance $(iid \sim N\ (0,\ \sigma^2))$. Equation 2 is characterised

by unit root if $\rho=1$ and the variance of P_t becomes non-stationary. For stationary achievement, the co-efficient (ρ) must be less than one in absolute value terms and this is denoted as $-1 < \rho < 1$.

Testing for the unit root is not a straightforward procedure and accordingly informal and formal tests are used. Formal procedures for unit root tests which appear often in econometric literature are the Augmented Dickey Fuller (ADF) and Philips-Person (PP) tests. Before giving an explanation of the ADF and PP tests, the Dickey Fuller procedure is explained.

4.5.4   Dickey Fuller unit root test

In conducting the test for unit root or searching for stationary time series, the standardised t-distribution is no longer employed. This is because the t-statistics will be large and negative and will lead to over rejection of the null hypothesis of non-stationary, meaning that the series will be stationary when it is not the case. In attempting to address this issue, the Dickey–Fuller test (DF) (1979) is used. It is a one-sided test that can be applied in three different forms of equations to test the presence of unit roots in a time series, namely no intercept and trend, intercept and trend, and intercept and no trend. The implementation of the DF procedure involves several decisions that should be made. Three statistically critical values are used for testing regression, namely $\tau, \tau_\mu, \tau_\tau$ (the symbols are referred to as tau). The statistically critical values depend on whether the equation contains trend and/or intercept. The Dickey–Fuller test for unit root involves the estimation of the equation to obtain ρ hat and further employing a standard t-test for the null hypothesis, but using a non-standardised set of critical values. The equations that follow explain the Dickey–Fuller procedure.

From equation 2, if P_{t-1} is substituted from the left and from the right hand side, the resulting equation will be as follows:

$$P_t - P_{t-1} = \rho P_{t-1} - P_{t-1} + \mu_t \tag{3}$$
$$\Delta P_t = (\rho - 1)P_{t-1} + \mu_t \tag{4}$$
$$\Delta P_t = \delta P_{t-1} + \mu_t \tag{5}$$

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In equation 5, the symbol Δ (delta) refers to the first difference operator, that is $\Delta P_t = P_t - P_{t-1}$ for each variable P and $\delta = \rho - 1$. Therefore, testing the null hypothesis of $H_{0:}\,\rho = 1$, is like performing a test for H_0 of $\delta=0$. The null hypothesis will then be written as H_0: $\delta =0$ (there is a unit root or time series is non-stationary) and the alternative hypothesis H_1: $\delta < 0$ or $\rho<1$ (the time series is stationary). Since $\delta = (\rho$-1) in order to obtain stationary ρ should be less than 1 ($\rho<1$). After the regression is run the t statistics are compared to the critical values, for example at 5 % level of significance. If the computed absolute value of the t statistics exceeds the absolute value of DF or MacKinnon critical value, then $H_{0:}$ $\delta=0$ is rejected and the H_1: $\delta < 0$ (alternative hypothesis) is accepted; this means P_t is stationary (no unit root).

Alternatively, if the absolute value of the calculated t-statistics does not exceed the absolute critical value, for example at 5 % level of significance, the null hypothesis $H_{0:}$ $\delta=0$ is not rejected and the time series is non-stationary (has a unit root), this means P_t is non-stationary. Theoretically, there is a possibility that the coefficient of ρ can be greater than 1, the underlying time series will be explosive and the series is said to be non-stationary, even if is significant at a particular statistically level of significance, thus when $\delta > 0$. Stability condition requires the coefficient of ρ to be less than one, and when this occurs, the series is said to be stationary.

4.5.5   Augmented Dickey Fuller unit root test

The Dickey and Fuller (1979) test of unit root employs the assumption that disturbance terms or error terms (μ_t) used in the models are uncorrelated. There could be autocorrelation in the data series and tests are necessary to detect serial correlation and further to remove the error terms, if found to be present. DF implementation is conducted in three different forms, thus stating three different types of null hypothesis (Gujarati & Porter, 2009).

In all sets of equation, there is a possibility of autocorrelation which can lead to estimation problems. In order to address the issue of error terms presence

when testing for unit root, Dickey and Fuller (1979) developed a modified version of DF called the Augmented Dickey Fuller (ADF) test. This method augments the three sets of equations by adding lagged values of the dependent variable (ΔP_t) in the regression model to take care of the error terms. In the case of this research, the effect on lagged values will be added into the model. However, a determination of how many lag values should be included in the model will be conducted statistically through the lag selection criteria. The generalised version of ADF model to be applied can be written as follows:

$$\Delta P_t = \beta_1 + \beta_2 t + \delta P_{t-1} + \alpha i \sum_{i=1}^{k} \Delta P_{t-i} + \mu_t \qquad (6)$$

As stated, the null hypothesis is $H_0: \delta = 0$ and the alternative hypothesis is $H_1: \delta < 0$ or $\rho < 1$. Restriction can be added in the model thus whether constant or trend is included in the model. Lag length is determined by the lag selection criteria. There are different approaches to the calculation of lag length, namely Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan–Quinn information Criterion (HQIC). For example, the formula for AIC can be written as follows:

$$AIC = 2 \left(\frac{L}{T} \right) + \frac{2nparms}{T} \qquad (7)$$

In the formula for calculating lags, L denotes value of the log likelihood at optimum, T denotes time period, and n_{parms} stands for total number of parameters in the model.

Theoretically, enough lags gives no serial correlation in the error term and many lags in the model can lead to a lower power of the statistics. In this process, for example, an Autoregressive AR (1) model is stated and δP_{t-1} is showing the lag to ensure that u_t is white noise. The ADF procedure for unit root tests is a test to determine the nature time series; it informs of the other tests that can be performed on the price data. If ADF tests reveal unit roots among time series

variables, the next step would be to test if co-integration exists between the price data.

4.5.6   Co-integration test

Econometric theory often suggests that regression of two non-stationary variables I (1) can lead to long-run equilibrium relationship and when that process occurs, co-integration exists. The method of the co-integration test tells whether there is a long-run relationship between non-stationary variables and was given formal treatment by Engle and Granger (1987). Price data which is non-stationary can be differentiated to become stationary. The first differencing stationary process provides integration of the order I (1). However, some data might be differentiated more than once to become stationary. The Engle and Granger (1987) procedure uses non-stationary data for testing of co-integration of variables in order to determine a long-run relationship. The procedure involves the use of Ordinary Least Squares (OLS) and the application of unit root tests. Critical to the application of the method, is to ensure equations balancing (Granger, 1981). This means random walk and covariance stationary cannot be co-integrated series. Same order of integration, for example I (1) with equal sign, makes the equation balance.

The Engle and Granger (1987) procedure uses an ADF method to estimate the residuals and to find if unit root exists. The technique provides for the identification of integration between markets, as well as the direction and degree of integration. The equation to be estimated can be written as follows:

$$\mathrm{P}_t^1 = \alpha_0 + \alpha_1 \mathrm{P}_t^2 + \mu_t \tag{8}$$

Equation 8 is re-written as follows:

$$u_t = \mathrm{P}_t^1 - \alpha_0 - \alpha_1 \mathrm{P}_t^2 \tag{9}$$

If P_t^1 (price of maize meal at provincial markets) and P_t^2 (price of maize meal at the central market) in equation 8 are individually I (1), the linear combination of the two prices when subjected to unit root testing (equation 9) can yield stationary series, I (0) or non-stationary series I(1). If I (0) is found, then co-

integration and a long-run or equilibrium relationship exists. Equation 8 then represents co-integration regression, with α_1 denoting the co-integration parameter. The co-integration vector is denoted as $(1, -.\alpha_1)$. In fact, the unit root test and co-integration test assist in determining if the residuals from the regression of equation 8 are stationary, I (0). The Autoregressive (AR) of the residual to be estimated can be written as follows:

$$\Delta\mu_t = p_1\mu_{t-1} + v_t \tag{10}$$

In equation 10 v_t is a white noise error process. In the AR model indicated, there is no constant term because residuals are from an equation with an intercept. It can be concluded that residuals are I (0) if the equation H_0 is rejected when $p_1 = 0$ and that $H_{1:} p_1 < 0$. Thus, if residuals in equation 8 are stationary with mean zero, then co-integration exists. This study uses Johansen method of co-integration to test for co-integration between urban and rural food prices. The Johansen test of co-integration is discussed below.

4.5.7   Johansen procedural test of co-integration

Johansen (1988) developed a procedure to test co-integration, based on multivariate tests. The procedure involves the use of a Maximum Likelihood (ML) test ratio and relies on ranked matrix and unit root characteristics. Johansen employed two methods in testing co-integration, namely Maximum-eigenvalue statistics and Trace statistics. The maximum statistics method is less used in most econometric analysis than the Trace statistics method. The method of eigenvalue calculation is employed to compute the Trace statistics. The procedure compares H_0 that there is r or fewer co-integration relations, against the alternative hypothesis that there is greater co-integration. It commences with a test of no co-integration (maximum rank zero); this proceeds to the accepting of H_0 which was not rejected in the first instance. A number of co-integrating equations can then be counted; this would depend on the number of series put to the test. The **Trace statistics** can be written as follows:

Trace test= Log $[L_{max}(r)/L_{max}(k)$ $r = k - 1, \ldots \ldots 1,0$ (11)

The Trace test, H_0 that co-integration is rank = r against the H_1 co-integration rank is = k.

The **Maximum statistics** can be written as follows:

Maximum Eigenvalue test:= Log $[L_{max}\,(r))/\,L_{max}\,((r+1)]r = 0,1 \ldots k, -1.$ (12)

The maximum eigenvalue test compares H_0 that co-integration is rank = r against the H_1 co-integration rank is $= r + l$. When co-integration is revealed through the Johansen test procedure, the next step is to apply a model of VECM to test effect between the variables. In this study, the VECM tests the effect of urban prices on rural food market prices.

4.5.8   Vector Error Correction Model

According to Engle and Granger (1987), if P_t^1 and P_t^2 are co integrated CI (1, 1), then I (0) is achieved. VECM is employed to model non-stationary time series I (1) so that stationary, I (0) is achieved. This means that VECM is the appropriate method to capture long-run and short-run dynamics between variables. In this research, VECM is used to show the relationship between changes in the dependent variable (price of maize meal in provinces) and in the independent variable (price of maize meal in central market). The model will further show lagged (past) values of the explanatory variable and will assist in exhibiting the extent of disequilibrium between dependent and independent variables, in this case P_t^1 and P_t^2. As a consequence, the rate at which the independent variable returns to equilibrium after a drift has occurred is estimated by the model. VECM will, therefore, assist in the capturing of the price adjustment process.

In the use of VECM, the behaviour of the dependent variable P_t^1 is tied to independent variable P_t^2 in equilibrium sense and that short-run changes in the dependent variable respond to drifts from the long-run equilibrium. The model used assumes a long-run relationship (co-integration) between prices of super

maize meal and employs the difference econometrically, in this case, prices of maize meal differences (dependent and independent variable). This study follows Engle and Granger (1987) model representation of the VECM. The model specification can be written as follows:

$$\begin{pmatrix} \Delta P_t^1 \\ \Delta P_t^2 \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} (P_{t-1}^1 - \beta P_{t-1}^2) + A_2 \begin{pmatrix} \Delta P_{t-1}^1 \\ \Delta P_{t-1}^2 \end{pmatrix} + \ldots + A_k \begin{pmatrix} \Delta P_{t-k}^1 \\ \Delta P_{t-k}^2 \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{t2} \end{pmatrix} \qquad 13$$

In equation 13, the symbol Δ (delta) represents the first difference operator which can be expressed as $\Delta P_t^1 = P_t^1 - P_{t-1}^1$. The parameter estimates within the matrix of A_2 up to A_k matrix capture the short-run dynamic effects between urban and rural food markets. The co-integrating parameter is represented by β which characterises long equilibrium relationship between two prices. The parameters which enter the ECM as a single entity $(P_{t-1}^1 - \beta P_{t-1}^2)$ are meant to capture drift from long run equilibrium relationship. The vectors, α_1 and α_2 represent the error correction coefficients and measure the speed of adjustment between P_t^1 and P_t^2 to restore long run equilibrium relationship. However, if two series are I (1) process and are not co-integrated, a short run dynamic effect model such as the Vector Autoregressive model or Autoregressive distributed lag model can be used to estimate the relationship between the variables. In this study Autoregressive Distributed Lag model is employed to estimate short run dynamic effects.

4.5.9   Autoregressive Distributed Lag models

When variables are non-stationary and co-integration does not exist, Autoregressive Distributed Lag (ADL) models or Rational Distributive Lag (RDL) models, as defined by Wooldridge (2013, p 611), can be used to estimate the relationship between dependent and independent variables. The ADL model is employed to test the null hypothesis of 'no effect of Y'. ADL models can provide similar test results as provided in the VECM model.

The difference between the two models (ADL and VECM) is that VECM uses non-stationary data to determine co-integration while ADL uses stationary time series data. With VECM, if one series is stationary and the other is not

stationary, co-integration cannot be determined as there will not be a balancing of equation (Granger, 1981), and this will include an inability to determine the short-term dynamics. The ADL model can provide an indication of short-term and long-term dynamics, as data employed in the model is transformed into stationary. The advantage of ADL models is that transformed data is used in the model, hence short-term and long-term dynamic effects can be determined. In addition, the ADL models can include lagged transformed data of X and Y plus non-transformed lags to explain the changes of Y. An illustration of the ADL model commencing with AR and DL model can be written as follows:

The AR (1) model

$$Y_t = B_0 + B_1 Y_{t-1} + u_t \dotfill (14)$$

The DL model

$$Y_t = B_0 + B_1 Y_{t-1} + B_2 Y_{t-2} + \cdots + B_p Y_{t-p} + u_t \dotfill (15)$$

The ADL model

$$\Delta Y_t = \alpha + B_1 \Delta Y_{t-1} + \delta_0 \Delta X_t + \delta_1 \Delta X_{t-1} + u_t \dotfill (16)$$

In the ADL (1,1) model described in equation 16, $\Delta Y_t \ and \ \Delta X_t$ denotes transformed variables and u_t is an error term. The model shows more predictors of Y, such as the values of X beyond the predictive lag value of Y. ΔY_{t-1} and ΔX_{t-1} denote transformed lagged values which are useful in the prediction of the dependent variable (ΔY_t). The ADL model can be estimated using Ordinary Least Squares (OLS) regression to determine the relationship between X and Y variables. However, to avoid problems of regression estimation, it is assumed that u_t is a white noise process that is stationary and is independent of the value of $\Delta X_t, \Delta X_{t-1}$ and further on the value of ΔY_t, and ΔY_{t-1}. To establish whether X values are significant to change Y, the null hypothesis of no short term and long-term effect will be tested against the alternative hypothesis. In the section that follows, a tool for analysing time series variables is discussed.

4.6 Methodologies weakness

This study uses three different types of method for the analysis of price relationships and/or market integration namely, Co-integration, VECM and ADL model.

Co-integration analysis can assist to find if there is a long-run relationship between urban and rural food markets prices. However, many authors argue that co-integration analysis is an insufficient technique to be used in the analysis of spatial markets (Barrett, 1996; Fackler & Goodwin, 2001; Barrett & Li, 2002). The technique is insufficient because it assumes that transaction costs are stationary. Transaction costs information was not available for this research although models such as TAR or PBM could have been employed to tackle this limitation they were not employed. The reason was mainly based on providing understanding of markets relationships, thus establishing if there is price transmission between rural and food markets. Co-integration became the appropriate method to use together with the VECM to estimate the co-integrated parameters. Although VECM does not uses thresholds and lead to continual price adjustment to even small price changes when there is deviations from the long-run equilibrium, the intension was to capture even such small price changes between markets locations. For example, during the time of analysis the price of 2.5kg super maize meal in SA was R13.98 and in MP the price was R15.35, the differences between the two prices were R 1.37. With these price differences the decision was to implement the VECM to see the effect of price changes between the markets. ADL method employment can lead to inefficient parameter estimates; the method was used to model three non co-integrated markets to check if short-run dynamics occurs. A test of market integration involves use of Granger causality when VECM is employed. Granger causality tests were less important in the analysis of study results, the purpose was to examine price transmission from urban to rural food markets and not vice versa.

4.7 Data analysis tool

In order to analyse time series data, an econometric statistical package, namely Eviews version 8.0, was employed. This tool is mainly used in time series econometrics analysis to establish the relationship between the variables. It can provide frequencies, tabulations, descriptive statistics, correlations and co-integration. Essential to this study is the point that the tool can relate non-stationary data econometrically to establish the nature of time series (unit root testing) and can assist in the estimation of co-integrated parameters through Vector Error Correction Modelling (VECM). Lastly, the tool can also be used on stationary data through ADL estimation procedure to give short-run dynamic relationships.

4.8 Summary and conclusion

In this chapter the research methods and the statistical procedures for analysing time series data were outlined. The sampling method used in this study was based on randomness. This was decided upon by the NAMC and Stats SA as the appropriate method to monitor food prices in the rural villages. Data was collected from the period of November 2006 to July 2012. To this effect, a total of 69 observations were used for analysis. The product chosen for the study was the 2.5 kg super maize meal package. The product choice was based on availability, uniformity of weight and on the trends that the product has showed from different provinces.

Time series data analysis procedures discussed included tests of stationary or non-stationary series. The statistical package used for data analysis is Eviews version 8.0, which is mostly used in time series econometrics. The initial step to test for stationary series involves the use of informal tests, namely graphs and ACF and correlogram. The formal test outlined relates to unit root test where ADF is used to test the nature of the time series. Two procedures for testing co-integration were also outlined, the Engle and Granger (1987) two steps procedure and the Johansen co-integration test. This research uses the latter to determine the long-run relationship between the non-stationary series. VECM is used to capture short-run and long-run dynamic adjustments between the non-

stationary variables. However, for variables that are not co-integrated, the ADL model becomes the appropriate model to test for short- and long-run dynamic effects, as the model uses stationary variables.

CHAPTER 5: RESULTS OF THE STUDY

5.1 Introduction

This chapter presents the results of the study on spatial market integration. In order to determine if co-integration exists between urban and rural food markets, prices of the 2.5 kg super maize meal were used in the analysis. The analysis followed time series procedures of using informal and formal tests to establish the nature of the time series. Markets are integrated if there are co-movements of prices between markets. When this occurs, a long-run relationship should exist between markets and trade is stimulated between the market actors. In this regard, market connection is created through arbitrage conditions which means the difference between market prices are less or equal to transaction costs. This further implies that higher prices in deficit areas will stimulate traders to purchase products from a lower price market to supply the deficit markets with products, thereby equalising the market prices. These simply reflect co-integration of markets through price transmission mechanisms.

When co-integration exists, market prices might not move together in the short run, owing to deviations from the long-run equilibrium, but after a certain period of time which can be days, weeks or months, equilibrium conditions will exist. Because of deviation from the long-run equilibrium, corrections to establish a long-term relationship will be econometrically conducted, including the speed and time of adjustment. A study of market integration will be incomplete without determining the extent to which shocks (errors) affect explanatory variables and their later effects on the entire system. The impact of shocks on the price relations between the markets will also be determined. Markets are at times not co-integrated; in such a case, the short-run dynamic effect will be tested.

The chapter is organised as follows: section 5.2 provides information on data analysis, section 5.3 deals with series statistics testing, and section 5.4 illustrates the lag selection criteria for use in the models. The Johansen co-integration test is explained in section 5.5, VECM is explained in section 5.6, diagnostic testing of models is explained in section 5.7, and the impulses are

described in section 5.8. ADL model results for non-co-integrated markets are explained in section 5.9. The chapter end with summary and conclusions in section 5.10.

5.2 Data analysis

The market price data analysed in this research was obtained from NAMC and Stats SA and was from the period November 2006 to July 2012. Analysis included the aggregated rural markets which were represented by their provinces, namely the Free State (FS), North West (NW), Western Cape (WC), Limpopo (LP), Eastern Cape (EC), Northern Cape (NC), Mpumalanga (MP), Gauteng (GP) and Kwa-Zulu Natal (KZN). The aggregated urban market price data was represented by a variable called SA. The analysis of spatial market integration between urban and rural food markets used formal and informal tests. Informal tests involved the use of graphs and the formal test involved the use of unit root testing.

5.2.1 Graphical analysis

Figure 13 below presents the graphical analysis of urban and rural food markets price data. By observing the plotted graphs in Figure 13, it can be seen that, overall, the direction of the average market price plots is trending upwards. On average, the prices of 2.5 kg super maize meal seem to have been lower during the year 2006, in spite of a price spike which was experienced in one month. Overtime and with the impact of general price increases and with other price effect factors, the industry experienced a continued increase in prices with fluctuations. Three components can be realised from the plotted graph, namely trends, price variability and seasonality.
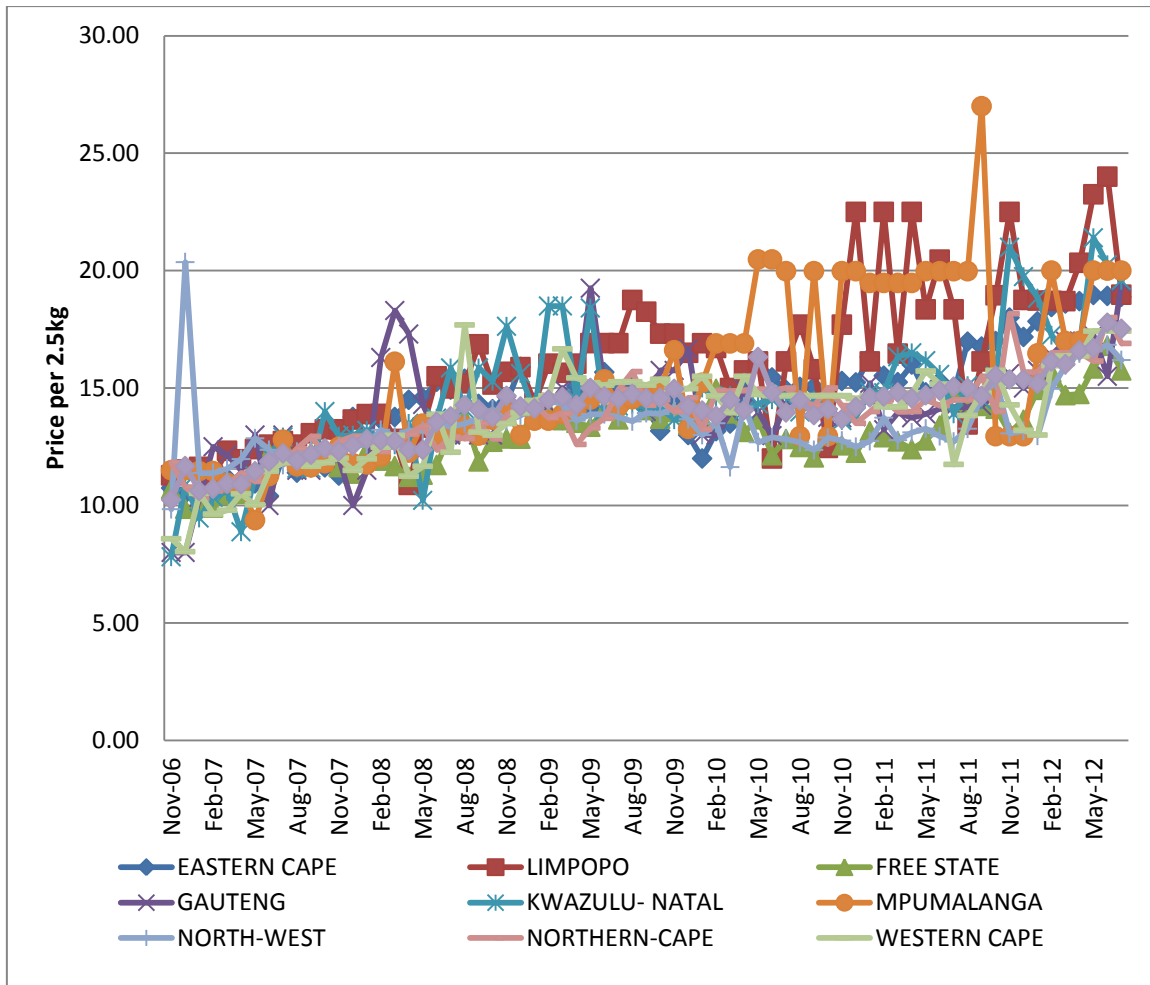
Figure 13: Time series price plots between rural and urban markets
Source: Stats SA and NAMC 2006-2012

An upward price trends is observed in the plots, and with these upward trends there is a high possibility of mean, variance and co-variance changes. Given the above price plots, it can be concluded that most of the rural food markets are non-stationary. The potential I (1) process identified and analysed will require transformation of the series to be I (0). This will provide an indication of what can be done with the data, going further into the analysis. However, a formal test such as unit root testing will confirm whether the data is stationary or non-stationary.

The second component showed in the plotted graph is price variability (increase and decrease in prices). The Coefficient of Variation (CV) was used to analyse price variability. The results showed a high price variation in Mpumalanga,

which was approximately 23 %, and this was followed by LP with a CV of approximately 20 %, by KZN with a CV of 19 %, and by EC, GP and WC with CVs of approximately 16 %. Spatial markets with lower CVs are NW, FS and SA. With these results, it can be concluded that provinces with high productions of white maize (for example, FS and NW) have less price volatility in maize meal prices. More information about the CV is provided in section 3.13 of Chapter Three.

The last component from the plotted graphs is the seasonality. Maize production in South Africa is seasonal, but unfortunately consumption is not seasonal. Moreover, the maize crop is the major input in the production of maize meal. With these direct linkages, a shortage and a surplus of maize in the country will each have an impact on the price of maize meal. Analysis of seasonality was conducted under unit root testing, and it can be concluded that the maize meal price data might have an element of seasonality from merely observing the trends in Figure 13, and this would have direct linkages to the supply and demand of maize meal in South Africa.

5.3 Series statistics testing

In this study ADF statistical test procedure was used to determine the nature of time series variables. Implementation of ADF for unit root was conducted in three steps, namely intercept, trend and intercept, and no trend and no intercept.

5.3.1 Test of unit root with a constant

Table 5 presents the summary statistics of variables that were tested for unit root, using the ADF method with a constant. In order to provide inferences from the test, the critical values of 1 %, 5 % and 10 %, together with the MacKinnon approximate p-value, were used. All variables tested showed a negative co-efficient of the lagged variable, which was expected. If the coefficients were positive (p >0), then it could have meant that explosiveness occurs, which is not desired. Variables which exhibit unit root are the average rural maize meal prices in the Eastern Cape (EC), Free State (FS), Northern Cape (NC),

Limpopo (LP) and Mpumalanga (MP) provinces. The null hypothesis of a unit root cannot be rejected for these five markets. This analysis is in line with the initial findings of the plotted graphs described in section 5.2.1, where many rural markets appeared to be non-stationary. Urban maize meal markets represented by the variable SA (South Africa) also showed a unit root. The null hypothesis of non-stationary cannot be rejected. The markets are characterised by a stochastic trend and unit root exists. In all the markets mentioned, the mean, variance and co-variance at levels are changing over time.

NW was found to be stationary at level. This can be interpreted as indicating markets that are integrated of the order I (0). The null hypothesis is rejected for this variable. Mixed results were found in other markets, namely GP, KZN and WC. Analysis revealed that these markets (GP, KZN and WC) are stationary at 1 % level of significance and non-stationary at 5 % level of significance. This suggests that variables can still be used for other analysis, although it is necessary to take caution.

Testing: H_o: p=1 (variable has a unit root)

` H_1: p <1 (variable is stationary)

Table 5: ADF test results for unit root in the variables

Variable	Status	Coefficient-lagged (V.L1) and (D.L1)	ADF test Statistics	MacKinnon P-value	Decision
EC	Level	-0.0504	-1.0394	0.7344	Unit root
LP	Level	-0.2111	-2.2339	0.1965	Unit root
FS	Level	-0.1209	-1.9902	0.2904	Unit root
GP	Level	-0.3047	-3.5185**	0.0103	Unit root
KZN	Level	-0.2490	-3.2309 **	0.0224	Unit root
MP	Level	-0.2098	-2.1691	0.2193	Unit root
NW	Level	-0.7910	-6.7091	0.0000	Stationary
NC	Level	-0.0637	-1.0171	0.7426	Unit root
WC	Level	-0.2187	-3.0438**	0.0359	Unit root
SA	Level	-0.0162	-0.3787	0.9062	Unit root

Single, double and triple asterisks indicate statistical significant level at α=0.01, 0.05 and 0.1.

5.3.2   Test of unit root with a constant and trend

Table 6 presents the unit root test results on constant and trend at levels. The results show that approximately six variables exhibits stationary mean, variance

and covariance. The null hypothesis of a unit root is rejected. Variables which appear to be non-stationary are EC, FS, and SA. Although the variables appeared to have unit root at 5 % level of significance except NC, the same variables appear to be stationary at 10 % levels of significance. With this analysis it can be concluded that the inclusion of trend and constant in the model made six variables stationary. This is the situation because testing of unit root taking into account the trend and constant makes series look stationary, and that is when seasonality is removed from the time series.

Testing: H_o: p=1 (variable has a unit root)

      ` H_1: p <1 (variable is stationary)

Table 6: ADF test results for unit root in the variables

Variable	Status	Coefficient-lagged (V.L1)	ADF Statistics	P-value	Decision
EC	Level	-0.3062	-3.3958***	0.0604	Unit root
LP	Level	-0.8369	-6.8136	0.0000	Stationary
FS	Level	-0.2924	-3.3037***	0.0743	Unit root
GP	Level	-0.4523	-4.4246	0.0039	Stationary
KZN	Level	-0.4926	-4.7400	0.0015	Stationary
MP	Level	-0.8030	-6.6100	0.0000	Stationary
NW	Level	-0.8900	-7.3403	0.0000	Stationary
NC	Level	-0.4338	-3.1329	0.1073	Unit root
WC	Level	-0.4396	-4.4205	0.0039	Stationary
SA	Level	-0.3009	-3.4442***	0.0540	Unit root

Single, double and triple asterisks indicate statistical significant level at α=0.01, 0.05 and 0.1.

5.3.3   Test of unit root with no constant and no trend

The ADF model results which test unit root with no constant and trend is not presented. The reason is that all the co-efficient of the lagged variables were found to be positive. The null hypothesis of a unit root cannot be rejected. A co-efficient of greater than zero (p>1) is a sign of explosiveness of time series data.

Testing: H_o: p=1 (variable has a unit root)

      ` H_1: p <1 (variable is stationary)

In conclusion, based on the sign of the co-efficient, the results of unit root tests are rejected and cannot be considered for further analysis.

5.3.4 Test of unit root using first differenced variables

To solve the problem of non-stationary and to remove autocorrelation in the data, series transformation was performed. The data was first differentiated in order to establish stationary or non-stationary. Table 7 present the results of unit root test with a constant as an example.

Testing: H_o: p=1 (variable has a unit root)

       ` H_1: p <1 (variable is stationary)

Table 7: ADF application on first differenced time series (constant)

Differenced variables	Coefficient- lagged (D.L1)	ADF Statistics	Decision
D.EC	-1.3517*	-11.6553	Stationary
D.LP	-2.3660*	-7.6956	Stationary
D.FS	-1.5013*	-8.0385	Stationary
D.GP	-1.2185*	-9.6021	Stationary
D.KZN	-1.7363*	-8.8008	Stationary
D.MP	-1.4816*	-13.6307	Stationary
D.NW	-1.4643*	-21.74305	Stationary
D.NC	-1.5235*	-14.3956	Stationary
D.WC	-1.4095*	-12.4857	Stationary
D.SA	-1.3859*	-12.6957	Stationary

Single, double and triple asterisks indicate statistical significant level at α=0.01, 0.05 and 0.1.

With differenced operator application to time series data, all variables became stationary. The interpretation is that all the coefficients (D(-1)), which are key in explaining stationary time series, turned out to be negative and were found to be less than one (p<1), as expected. Probability values are less than all significant levels of 1 %, 5 % and 10 %, respectively. The null hypothesis that there is a unit root in the data series is rejected. The decision is that all variables are stationary, after first differencing.

5.3.5 Stationary time series

After the ADF procedure implementation on first differencing, all time series became stationary (see Figure 14). This means that the mean, variance and covariance do not change over time. When a stationary condition is determined, other analysis, which uses an Autoregressive Distributive Lag (ADL) model, a

Vector Autoregressive (VAR) model and a GRACH method, can be applied. Estimation and forecasting problems will be at the minimum when stationary data are employed. However, for the purpose of this research, the interest lies in the determination of spatial price relations and therefore non-stationary variables is employed.
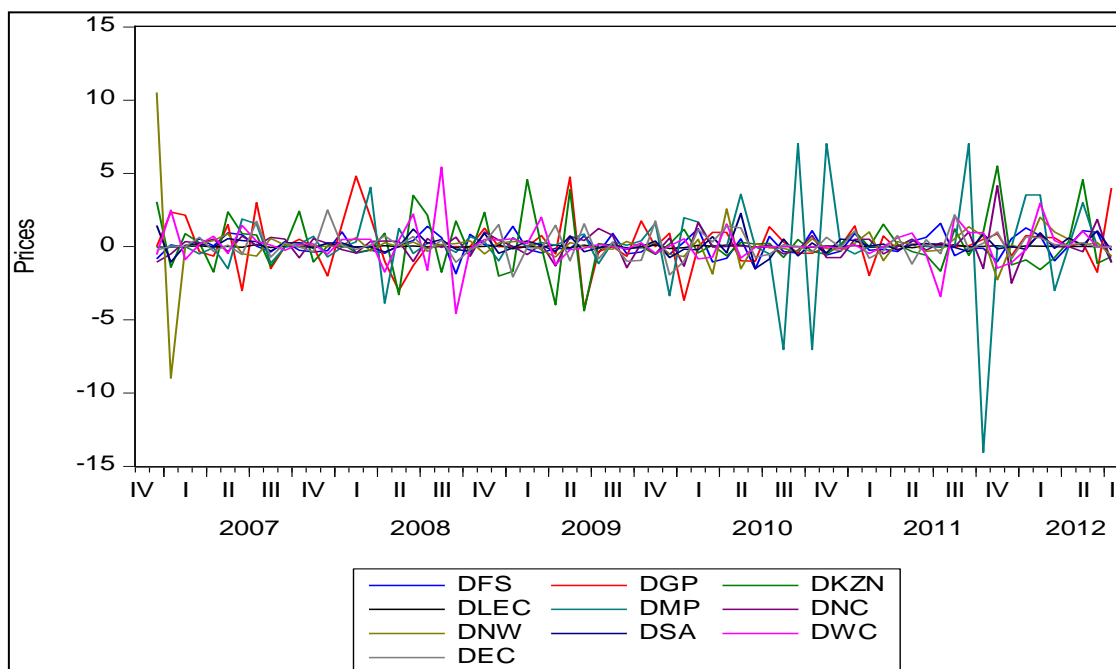
Figure 14: Stationary time series for differenced prices

In this section, formal and informal tests were implemented to test and to analyse if variables have unit root. Based on the results obtained, it is concluded that nine price series, namely SA, FS, EC, MP, WC, GP, LP, MP and NC, have a unit root. The null hypothesis of a unit root cannot be rejected; it is rather accepted and the decision is that variables are non-stationary. The null hypothesis of a unit root is rejected for NW and the alternative hypothesis is accepted. With the presentation of these test results, other econometric analysis with models, such as ADL for stationary series and VECM model for non-stationary series, can be applied. However, before use of econometric models, diagnostic tests are applied to the price data to determine number of lags that should be incorporated into the models.

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5.4   Lag selection order criteria

According to Wooldridge (2013), lag length is dictated by the frequency of the data, as well as by the sample size. The inclusion of many lags in the model leads to a reduction of the observations, and furthermore, the small sample power of the test might generally suffer. This research involves observations that were recorded monthly; the suggestion by Wooldridge (2013) is to use 12 lags in the model. However, there are no hard rules or principles to follow when lags are included in the model to tackle the problem of serial correlation.

A diagnostic test was used to acquire correct statistical lag order selection. The diagnostic tests implemented a VECM procedure. The results of the tests are provided in Table 8 which shows various criteria, namely AIC, FPE, SC, LR, and HQ. The guiding principle for choosing lags is based on the lowest value consideration which corresponds with the asterisk (*) in the model. Statistical analysis shows that, on average, lag length for all the variables is between one and two. In the analysis which follows, lag one and two are incorporated into the models, according to the lag selection criteria guide.

Table 8: Summary of lag selection-order

Variables	Lags	LL	LR	FPE	AIC	SC	HQ
EC	2	-115.7	13.940	0.185*	3.991*	4.3318	4.125*
LP	2	-173.5	10.580*	1.162*	5.825*	6.165	5.959*
GP	1	-158.1	122.129*	0.627*	5.210*	5.414*	5.290*
FS	2	-99.8	11.506*	0.112*	3.486*	3.826	3.620*
WC	1	-138.0	114.753*	0.331	4.572	4.776*	4.652*
NC	2	-109.9	10.128*	0.154*	3.806*	4.146	3.940
MP	2	-189.9	10.146	1.956*	6.346*	6.686	6.480
KZN	2	-155.7	8.365	0.661*	5.261*	5.601	5.395

NB: Asterisk (*), indicates lag order selected by the criterion

LR: = LR test statistics, FPE = Final Predictor error, AIC = Akaike information criterion, SC = Schwarz information criterion, HQ = Hannan–Quinn Information criterion

5.5   Johansen co-integration test

In order to determine the existence of prices that move together between food markets in different locations, a co-integration analysis was conducted. The test of co-integration employed a Johansen co-integration test. With these tests, it was assumed that variables under consideration are non-stationary in their level form, but when these variables are first differentiated, they become stationary. A

co-integration test was performed between unit root variables to see if the variables had a long-term association.

Table 9 provides the summarised results of the Johansen test of co-integration. The tests use trace statistics and max statistics together with probability values to confirm co-integration. From the tests results, line one in Table 9 shows null hypothesis of no co-integration, denoted by an asterisk (*). Line 2 in Table 9 shows co-integrating equation(s). It is important to note that once there are no co-integration parameters in line 1 of Table 9, line 2 automatically becomes the null hypothesis.

Testing: H_o: There is no co-integration

H_1: There is co- integration

Table 9: Johansen test of co-integration

Variables	Maximum rank	Eigen value	Trace stats	Probability value	Max Eigen stats	Probability value
FS	0*	0.229242	17.63099	0.0235	17.18516	0.0168
FS	1	0.006732	0.445828	0.5043	0.445828	0.5043
LP	0*	0.223442	17.14974	0.0279	16.69030	0.0203
LP	1	0.006937	0.459440	0.4979	0.459440	0.4979
EC	0	0.126764	9.905804	0.2880	8.946241	0.2907
EC	1	0.014434	0.959563	0.3273	0.959563	0.3273
WC	0*	0.227205	17.33553	0.0261	17.01094	0.0179
WC	1	0.004906	0.324596	0.5689	0.324596	0.5689
NC	0*	0.222738	16.95018	0.0300	16.63051	0.0207
NC	1	0.004832	0.319669	0.5718	0.319669	0.5718
MP	0	0.124862	9.270471	0.3410	8.802698	0.3029
MP	1	0.007062	0.467773	0.4940	0.467773	0.4940
KZN	0*	0.227444	17.50312	0.0246	17.03132	0.0178
KZN	1	0.007123	0.471801	0.4922	0.471801	0.4922
GP	0*	0.304096	24.46318	0.0017	23.92786	0.0011
GP	1	0.008078	0.535322	0.4644	0.535322	0.4644

NB: Double asterisks indicate statistical significant level at α= 0.05.

Granger (1981) pointed to "equation balancing" when testing for co-integration between the markets. To balance the equation, unit root market variables were used to test co-integration between the urban and rural food markets. According to Johansen test results (see Table 9), out of the eight rural markets (excluding the North West) which were selected for co-integration analysis, approximately six markets were found to be co-integrated with the urban market. The null

hypothesis of co-integration cannot be rejected for six rural markets. The probability values of the six markets tested and their corresponding trace and max statistics were found to be more than the 1 % and 5 % levels of significance. This provided sufficient evidence that markets are integrated and that there is only one co-integration.

The analysis confirms price co-movement and a long-term relationship between average prices of 2.5 kg super maize meal in urban and rural markets. This means there is spatial market integration which occurs through a price transmission process. Implementation of the Johansen tests led to the establishment of price stability in the long run. Variables that showed long-term relationships with the average urban market price are FS, NC, LP, WC, GP and KZN. The decision is that there is only one co-integration relationship from each model that was run, and this is confirmed by both the trace statistics and max statistics, as shown in Table 9.

The Johansen co- integration tests further revealed no co-integration between urban and two rural markets, namely EC and MP. This is the case, in spite of the unit root confirmation by the ADF. The probability value corresponding to trace statistics in EC is 28.80 %, and again the probability value corresponding to max statistics in EC is 29.07 %. This provides sufficient evidence for not rejecting the null hypothesis of no co-integration but rather to accept that there is no price co-movements. With regard to MP, the probability value corresponding to trace statistics is 34.10 %, and again the probability value corresponding to max statistics is 30.29 %. Since the two values are more than the 5 % level of significance, the null hypothesis of no co-integration cannot be rejected. In conclusion, the two rural food markets (EC and MP) are not connected with the urban market.

The analysis confirmed that there is no price transmission taking place between EC and SA and again between MP and SA. This means that there is a problem with regard to price stability in the two provinces' rural markets. Important to note is that analysis on structural determinants of market integration was not

conducted in this study due to unavailability of data. However, Goletti *et al.*, (1995), shows that structural factors in particular marketing infrastructure related to transportation and communication, actions of the traders and policies are mainly factors responsible for market integration. With these listed factors it can be said that structural problems might be the reasons why spatial markets do not integrate and further research is needed to identify exact factors responsible for lack of integration. The implication is that if rural markets are not integrated with the urban markets, the households purchasing food from the markets are likely to experience problems of high food prices, poverty and food insecurity. Although there is no long-run relationship between the markets identified, ADL model can be applied to establish short-term dynamic effects. However, when co-integration exists, VECM is appropriate technique to estimate the parameters of the co-integrating equations.

5.6 Vector Error Correction Model

The VECM is appropriate to use when variables are integrated of the same order. VECM is employed in the analysis to estimate the parameters of co-integration equations. This dynamic model accounts for deviation of time series movement from the current state of potential long-run equilibrium relationship. The model further assists to determine the short-run dynamic effects to the long run. With VECM, the speed of adjustment to long-run equilibrium can be determined and short-term effects of the estimated parameters can be investigated. In the section that follows, the results of VECM are provided for co-integrated markets, as identified by the Johansen co-integration test.

5.6.1 VECM test results between urban and rural food markets

Table 10 presents the VECM regression results of the estimated parameters of co-integration. The targeted equation is the differentiated average rural maize meal price, which represents the dependent variable of the provinces that showed co-integration. Independent variables in the equations are represented by the Wald statistics which is a joint test of significance.

Table 10: VECM tests results for co integrating variables

ECM (Co-int)	Coefficient	T statistics	Probability	Wald-Test
Eq1 LP-SA	-0.648453	-3.245141	0.0019*	0.053***
Eq2 FS -SA	-0.395805	-2.462241	0.0167**	0.046***
Eq3 WC-SA	-0.774075	-4.083880	0.0001*	0.3657
Eq4 NC-SA	-0.514892	-3.015184	0.0038*	0.8903
Eq5 GP-SA	-0.729279	-4.772622	0.000**	0.4392
Eq6 KZN-SA	-0.574757	-3.021365	0.0037*	0.8670

Single, double and triple asterisks indicate statistically significant levels at α=0.01, 0.05 and 0.1.

5.6.1.1 _Long-run dynamics and speed of adjustment_

The VECM test results show that all the co-integration equations are negative and are varying in magnitude. The negative signs in all the co-integrating equations/error correction terms were established, as expected. The probability values corresponding to the coefficients are very small and less than the critical values of 1 % and 5 % levels of significance. The null hypothesis of no long-run relationship is rejected. This means that the explanatory variable (SA) has a long-run causality effect on all the rural food markets tested.

The speed of price adjustment is important in the study of spatial market integration, thus it is necessary to establish the time (days, weeks or months) it takes for the prices to be transmitted from one market to the alternative market. The results show dynamic adjustment, which is from SA to all the rural food markets, namely LP, FS, WC, NC, GP and KZN. The co-integration terms are statistically significant, at 1 % and 5 %, respectively. This explains the significant speed of adjustment towards the long-run equilibrium after deviations has occurred in the markets. The co-integration terms are adjusting at various and fast speeds. This suggests that transaction costs influence linkages between urban and rural food markets. In LP rural food markets, the speed of price adjustment is approximately 65 %, in FS the speed of price adjustment is 40 %, in WC the speed of price adjustment is 77 %, in NC the speed of price adjustment is 52 %, in GP the speed of price adjustment is 73 %, and lastly, the speed of price adjustment in KZN is 58 %. On average and in absolute terms, the speed of price adjustment is fast (transaction costs significantly affect

linkages between urban and rural food markets) in all the markets analysed, except in FS where prices seem to be adjusting at a lower speed of approximately 40 %. According to Goletti *et al.* (1995), rapid adjustments towards the long-run equilibrium give an indication of mechanism flexibility and do not necessary mean the good functioning of systems.

Corrections in the markets are made monthly, but the speed of price adjustment is different between the markets. However, it appears that where the speed of price adjustment is lower, the time period of adjustment is shorter. In FS, the speed of adjustment is approximately 40 % and it takes about 2.46 month for prices to stabilise. In LP, the speed of adjustment is approximately 65 % and it takes three month for prices to stabilise. In the WC, the speed is 77 % and it takes about 4 month for prices to stabilise, in NC the speed is approximately 52 % and it takes about 3 month for prices to stabilise, and in GP the speed of adjustment is approximately 73 % and it takes about 5 month for prices to stabilise. Lastly in KZN, the speed is approximately 58 % and it takes about 3 month for prices to stabilise. From the analysis made, it can be concluded that the shorter the time period needed to complete the price adjustment, the more the spatial market becomes integrated.

5.6.1.2   *VECM short run dynamics between urban and rural markets*

In order to detect the effect of independent variables towards the long-run equilibrium relationship, a joint coefficient test was conducted. The results of short run coefficient tests are represented by the Wald tests, as shown in Table 10. According to the test results, there appear to be short-run causality in some of the rural markets. The coefficient of SA lagged one (SA (-1)) in the FS is negative, and the corresponding probability is about 0.04, which is less than 5 % level of significance. This means that in the short run, SA lag one causes the FS rural food market price to change. In FS, the joint probability value corresponding to Chi-square is 0.046 and it is less than 5 % and 10 % levels of significance. Jointly, the coefficients of SA, as shown by the Wald test,

significantly causes prices of 2.5 kg super maize meal to change in FS in the short run.

Similarly in LP, the coefficient of SA lagged one (SA (-1)) is negative (-1.335) and the corresponding probability value is about 0.02, which is less than 5 % level of significance. There appears to be short-run effects of SA lag one which causes LP rural food market prices to change. The coefficient restrictions/joint probability value corresponding to Chi-square is 0.054 and it is less than 10 % level of significance. The interpretation is that jointly the coefficients of SA as shown by the Wald test significantly cause prices of 2.5 kg super maize meal to change in LP in the short run.

The joint statistics tests in the other markets were found to be insignificant. The short-run dynamics effects were not found in the rural food markets of WC, NC, GP and KZN. This means that in the short run, prices of the 2.5 kg super maize meal in urban markets do not shift the prices of maize meal in the rural markets mentioned.

5.7 Diagnostic tests of the models

In order to be certain about the results of the model employed in the analysis, model efficiency was implemented. This involves tests of residuals normality, serial correlation and residual distribution. Table 11 provides the results of the diagnostic tests.

Table 11: Residual diagnostic tests between the markets

ECM (Coint)	LM Test	JB Test	ARCH Test
Eq1 LP-SA	0.8584	0.003*	0.9056
Eq2 FS -SA	0.2582	0.629	0.2347
Eq3 WC-SA	0.8905	0.000*	0.6184
Eq4 NC-SA	0.8935	0.000*	0.9913
Eq5 GP-SA	0.8142	0.000*	0.1247
Eq6 KZN-SA	0.1056	0.016**	0.6140

Single, double and triple asterisks indicate statistically significant levels at α=0.01, 0.05 and 0.1.

According to the Breusch-Godfrey serial correlation LM test results presented in Table 11, the null hypothesis cannot be rejected for all the markets. The

probability values are more than the critical values of 1 %, 5 % and 10 % levels of significance. This means that there is no serial correlation in all the models which were run. If there is no autocorrelation, it means that there is no evidence of model misspecification and the entire system model is correct and can be accepted.

According to the Jarque-Bera (JB) test results presented in Table 11, the null hypothesis of a residual normal distribution is rejected in LP. The probability value is less than the critical value of 5 % level of significance. This denotes that residuals are not normally distributed in LP. However, in the FS the residuals are normally distributed and the null hypothesis cannot be rejected. The probability value is more than the critical value of 5 % level of significance. Test results further show that other markets, namely the WC, NC, GP and KZN, residuals are not normally distributed. Although efforts were made to transform data, the non normality still remained in some markets and this is attributed to data limitations as 69 monthly observations were used. This condition might have impact towards making accurate conclusions about the price relationships between urban and rural markets.

The Auto Regressive Conditional Heteroskedasticity (ARCH) tests revealed that there is no ARCH effect in all the models. The probability values are more than the critical values of 1 %, 5 % and 10 % levels of significance. This means there is no ARCH effect/ Heteroskedasticity in all the models which were run. If there is no ARCH effect, it means that there is no problem with the model used and the results can be accepted. Overall, the models are desirable and can be accepted as providing good representation in the modelling of the time series data.

5.8   Impulse response function

Tests of market integration usually consider the extent to which shocks are transmitted among spatially separated markets (Goodwin & Piggott, 2001). In attempting to capture the shocks between the urban and rural food markets, the Impulse Response Function (IRF) was employed. The IRF assists in the

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determination of the effect of shocks on the adjustment path of parameters. A shock is considered to be any of the changes from outside the system which affects the independent variables, and which through transmission process further affects the entire system.

Figure 15 presents the response of FS to SA, given the one standard deviation which was added into the model. Other IRFs between urban and rural food markets are presented in Annexure 1 to Annexure 5.
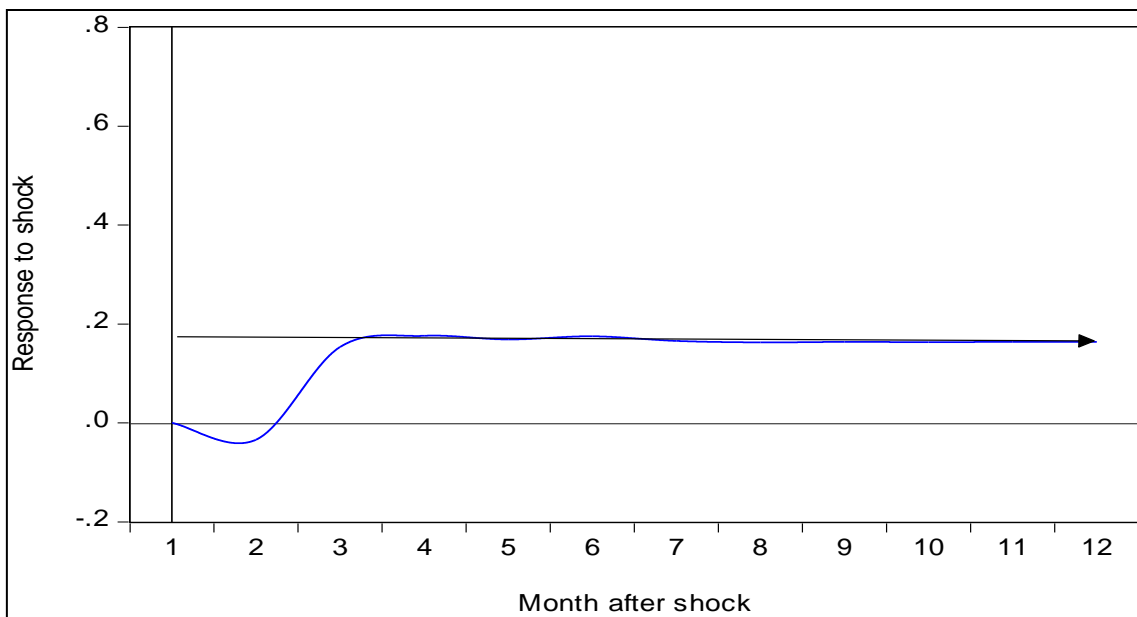

Figure 15: Response of FS market from price shocks in SA market
Source: NAMC, Stats SA, Author's computation

The IRF results show that after deviations have occurred in the market, prices converge to long run equilibrium relationship as shown in Figure 15. The results further show a period of between three and seven months for negative and positive shocks to be eliminated in the market. The decrease and normalisation in prices have implications for both traders and consumers. Lower price of maize meal is good for the consumers but the challenge might be product availability in the rural market. This is because at lower price of maize meal, traders might not have incentives to engage in trade and this could lead to distribution challenges for the traders. Overall, the markets tested revealed a period of between two and eleven months for negative and positive impulses to

be cleared in all the markets. The long period of dynamic price adjustment implies weak effect in the other rural markets and suggests that transaction costs have significant influence in the spatial market integration.

5.9   Autoregressive Distributive Lag model

When co-integration does not exist between non-stationary variables, it means that there is no long-run equilibrium, therefore only short term dynamics can be determined. The Autoregressive Distributive Lag (ADL) model then becomes the appropriate model to use when data is stationary. This implies that data must be transformed from non-stationary to stationary series; otherwise there will be problems in the estimation. Section 5.5 tested the non-stationary variables between urban and rural markets. The results revealed no co-integration between urban and two rural food markets, namely MP and EC. Furthermore, it was established through unit root testing in section 5.3.1 that NW was stationary at levels and co-integration could not be performed. Since co-integration was not performed in three rural markets (EC, MP, NW), the only alternative is to establish whether there is a dynamic short-term effect on rural food markets.

5.9.1   ADL model test results between EC and SA food markets

Table 12 presents the ADL regression results of the estimated stationary parameters between EC and SA. The ADL model results include the current and lagged values of SA (D1sa and D1saL1) and the lagged value of EC (D1ecL1) as explanatory variables. The results show that the co-efficient of differenced lagged value in the rural Eastern Cape (D1ecL1) is statistically significant at 1 % level. This denotes that past prices in rural maize meal markets have an effect on the current prices. The results further show that, ceteris paribus, the co-efficient of SA (D1sa) is statistically significant at 1 % level. This means that in the short run, the change in the price of maize meal in urban markets (SA) significantly causes prices of 2.5 kg maize meal in EC to change. The null hypothesis of no short-run price changes in SA is rejected and the alternative hypothesis is accepted. The speed of price change is moderate, at 53 % in the rural Eastern Cape maize meal markets. The lagged co-efficient

of SA (D1saL1) was also found to be significantly influencing a change in the prices of 2.5 kg maize meal in the short run. The post estimation technique has revealed a joint co-efficient test in EC at 0.01 level of significant. This confirms the existence of short run dynamic integration.

Table 12: ADL test results between EC and SA

Eq2 EC-SA	Coefficient	Std Errors	T-statistics	Probability
D1ecL1	-0.4116104*	0.111898	-3.68	0.000
D1sa	0.5327356*	0.1959452	2.72	0.008
D1saL1	0.4780131**	0.1909956	2.50	0.015
cons	0.0750367	0.1029828	0.73	0.469

Single, double and triple asterisks indicate statistically significant levels at α=0.01, 0.05 and 0.1.

5.9.2   ADL test results between NW and SA food markets

The ADL regression results between NW and SA are presented in Table 13. The results show that the co-efficient of differenced lagged value in the rural Northwest (D1nwL1) is statistically significant at 1 % level. This means that past prices of rural maize meal markets have an effect on the current prices. The results further show that, ceteris paribus, the co-efficient of SA (D1sa) and (D1saL1) are not statistically significant. This denotes that in the short run, the change in the price of maize meal in urban markets (SA) does not cause prices of 2.5 kg maize meal in NW to change.

The post estimation results for joint co-efficient test reveal that the probability value corresponding to NW is 0.322. This probability value is higher than all significant levels and it is a clear indication that the null hypothesis of no short run effect cannot be rejected. This means, *ceteris paribus*, changes in the price of 2.5 kg super maize meal in the urban markets (SA) do not cause the price of 2.5kg super maize meal to change in NW rural markets. The conclusion is that there is no dynamic short-run integration in the NW food market.

Table 13: ADL test results between NW and SA

Eq1 NW-SA	Coefficient	Std Errors	T-statistics	Probability
D1nwL1	-0.4701159*	0.0709802	-6.62	0.000
D1sa	0.3683478	0.2470215	1.49	0.141

D1saL1	0.0869436	0.2490537	0.35	0.728
cons	-0.0550134	0.1293892	-0.43	0.672

Single, double and triple asterisks indicate statistically significant levels at α=0.01, 0.05 and 0.10.

5.9.3   ADL test results between MP and SA food markets

Table 14 presents ADL regression results of the estimated stationary parameters between MP and SA. The ADL model results include the current and lagged values of SA (D1sa and D1saL1) and the lagged value of MP (D1mpL1) as explanatory variables. According to the results, the coefficient of lagged value of MP (D1mpL1) is negative, as expected. The probability value corresponding to the D1mpL1 is less than 1 % level of significance. These results denote that past maize meal prices in MP has an influence on the current prices of 2.5kg maize meal.

The results further show that, ceteris paribus, the co-efficient of the current and lagged prices in SA market are not significant to influence prices in the rural Mpumalanga maize meal markets. The probability values corresponding to the coefficients are more than all the significant levels of 1 %, 5 % and 10 %, respectively. The null hypothesis of no short-run effect cannot be rejected. The post estimation results for joint co-efficient test reveal that the probability value corresponding to MP is 0.798. This probability is higher than all significant levels and it is a clear indication that the null hypothesis of no short run effect cannot be rejected. This means changes in the price of 2.5 kg super maize meal in the urban markets do not cause the price of 2.5kg super maize meal to change in MP markets. The conclusion is that there is no dynamic short-run integration in the MP rural food markets.

Table 14: ADL test results between MP and SA

Eq3 MP-SA	Coefficient	Std Errors	T-statistics	Probability
DmpL1	-0.474558*	0.1118337	-4.24	0.000
D1sa	0.0299503	0.6469882	0.05	0.963
DsaL1	0.3915554	0.6154604	0.64	0.527
cons	0.1403956	0.3373938	0.42	0.679

Single, double and triple asterisks indicate statistically significance level at α=0.01, 0.05 and 0.10.

5.10   Practical aspects of spatial markets integration

Maize meal is considered to be a food security product in South Africa and is traded in most urban and rural markets. The results obtained showed that about six rural food markets namely FS, NC, LP, WC, GP and KZN have long run relationship with urban markets and about three markets did not have a long term relationship.

The implications for long-run relationships are that: (1) rural households purchase maize meal product at a price that is reflected in the urban markets although the prices are not the same due to price differentials that exists in market locations, (2) household's livelihoods are not made worse off as traders seem to receive market signals that are reflected in the product price. Although prices of the urban markets are reflected in the rural markets in the long-run, this is not occurring at the time due to different periods of price adjustment in different provinces. This might be due to "sticky prices", which happens when markets fix prices of products in the short run.

The short-run implications are that only two markets namely FS and LP show changes in prices of maize meal. This implies that households receive price changes on maize meal quicker and they can be able to adjust their spending as and when prices increases and decreases. However, about six markets did not exhibit short-run dynamic effects and this might imply that changes from urban markets are not large enough to effect changes in the rural markets identified.

Structural determinants of market integration were not conducted in this study due to unavailability of data. However, Goletti *et al.,* (1995), shows that structural factors in particular marketing infrastructure related to transportation and communication, actions of the traders and policies are mainly factors responsible for market integration. With these factors it can be said that structural problems and other factors such as actions of the traders might be the reasons why spatial markets integrated or do not integrate. However, further

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research is needed to identify exact factors responsible for lack of market integration in the identified markets.

5.11   Summary and conclusion

In this chapter, formal and informal methods of testing unit root were used to establish the nature of the time series. The results show that out of the nine markets which were measured for spatial integration, six of the rural food markets were co-integrated with urban markets. One market (NW) was found to be stationary at levels and co-integration could not be applied due to the nature of time series which exhibited I (0). The analysis also revealed that two markets, namely EC and MP, were not co-integrated.

Integrated food markets often have a long-run equilibrium relationship. To determine the equilibrium relationship, speed of adjustment and time of adjustment, a VECM was used in the analysis. The implementation of VECM revealed a long-term relationship between the six co-integrated rural food markets with the urban market, although there were deviations in the short run. Markets showed different speed of adjustments to the long-run equilibrium price and different time of adjustment. In absolute and aggregate terms, the speed of price adjustment was faster (65 %) in five markets, and only one market (FS) showed a slower speed (40 %) of adjustment. Fast speeds of price adjustment to long-run equilibrium relationships suggest that transaction costs have significant effects on the linkages between urban and rural food markets. With regard to the time period of price adjustment to the long-run equilibrium, the results show that it takes about two to five months for markets to reach equilibrium.

VECM test for short run dynamics effects has revealed causality effects in FS and in LP rural food markets. The joint probability value in FS is 0.046, and the joint probability value in LP is 0.054. These probability values are less than 5% significant level in FS and less than 10 % significant level in LP. This implies that jointly, the coefficients of SA as shown by the Wald test statistics

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significantly cause prices of 2.5 kg super maize meal to change in FS and in LP rural food markets.

Further test of short-run dynamic effects by ADL techniques among non-co-integrated markets revealed significant short-run dynamic effect between urban and rural food market of the EC. The short-run dynamic effect was found to be significant at 1% level. This implies that in the short-run, *ceteris paribus,* changes in the price of 2.5kg super maize meal in the urban markets lead to a price change in EC. This result was further confirmed by the joint co-efficient test in EC at 0.01 level of significant. Short-run dynamic effects in MP and NW were found to be insignificant.

IRF investigation between FS and SA revealed that it takes about three to seven months for negative and positive shocks to be completely eliminated from the market and for the markets to normalise. However, the totality of all IRFs in the six co-integrated markets revealed that it takes about two to eleven months for negative and positive shocks to be cleared from all the markets.

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

Market integration is important in the South African economy. This is because market integration can provide an indication of development from the central developed economies, where there are good roads and communication infrastructure, to the under-developed rural areas. Within this context, market integration can serve as a precondition for the effective development of the South African economy. When markets are integrated, it can be said that market forces of demand and supply are working effectively. If markets are integrated, policy change relating to food distribution in one region will be transmitted to the other markets. Without market integration, prices will not be transmitted between the market locations and price equalising arbitrage activities will not be triggered. Surplus and deficit regions cannot trade, as there will be poor information flows between the markets. Understanding and knowledge of market integration further allows identification of structural factors that are responsible for lack of market integration. In order to improve the performance of markets through a policy development mechanism, a better understanding of how markets operate and relate with each other is essential.

The main objective of this study was to measure spatial market integration between urban and rural food markets in light of the continued increases in food prices for basic products which have an impact on price differentials. Essential to the study, was to investigate whether markets integration exists between rural and urban food markets and to analyse the relationships between the markets. Furthermore, it was also important to determine the existence of long-run equilibrium relationships between the rural and urban markets. Through a literature review, it was established that there has not yet been any study conducted on spatial market integration between rural and urban markets in South Africa.

6.2 Literature review

Spatial price theory states that price difference between regions cannot exceed transaction costs (Tomek & Robinson, 1995). In a competitive market economy,

if the price difference between regions exceeds transactional costs, buyers will purchase commodities from the low price market and ship them to the high price market. This will raise prices in the lower-price market and reduce prices in the higher-price markets. Arbitrage opportunity is created when the price difference between two market locations exceeds transaction costs. However, the size of transaction costs between markets is critical, as arbitragers aim to make profit through the value chain process. According to Meyer (2006), arbitrage has the effect of causing prices in different markets to converge and, therefore, for markets to integrate. If the arbitrage condition is violated, it means that there is a problem with regard to trade and this can be viewed as evidence of poor spatial market integration (Baulch, 1997).

In analysing spatial price relationships, attention has been drawn to the use of spatial price equilibrium models (Enke, 1951). Literature on measuring market integration shows different approaches to measure and analyse market integration. The approaches include correlation coefficient of prices (Lele, 1972); short- and long-run measures of integration (Ravallion, 1986); long-term multipliers and time to adjust (Medonza & Rosegrant, 1991); and a co-integration approach (Goodwin & Schroeder, 1991; Palaskas & Harris, 1991). An error correction approach was developed by Engle and Granger (1987) and parity bound models were developed by Spiller and Wood (1988) and Baulch (1997). Mendoza and Farris (1992) used causality and centrality tests to measure market integration.

According to Goodwin and Piggott (2001), transaction costs are important to consider in spatial price relationships, even though they are unobservable to the researcher. With the measurement of spatial market integration, it is important to factor transaction costs into the models. However, various researchers (Delgado, 1986; Barrett, 1996) have criticised the use of correlation price matrix and co-integration approaches in measuring spatial market integration on grounds that the approaches do not take into consideration transaction costs. The use of simple price-based regression models can lead to spurious relations, which can further lead to wrong conclusions about market integration (Delgado,

1986, Barrett, 1996). The use of the two methods can further lead to continuous adjustments to the long-run equilibrium, even when there is a small deviation. The presence of transaction costs might lead to a "neutral band" which will result in the system not having a continuous adjustment. The neutral band will disconnect the prices in the system and price equalising activities will be activated when local shocks result in price differences that exceed the neutral band.

Considering the challenges posed by the correlation and co-integration methods, a method of Threshold Autoregressive (TAR) by Tong (1987) was developed to take into account transaction costs. Further development of TAR led to the bringing together of co-integration and non-linearity, and the model of the Vector Error Correction Model (ECM) emerged. VECM is used to model dynamic relationships and can relate current and previous prices when co-integration exists. The model discussed provides a general specification of modelling non-stationary data and can reduce the use of different modelling. Other models that can take into account the issue of transaction costs are the Threshold Vector Error correction Model (TVECM) and the Parity Bound Model (PBM) which was developed by Baulch (1997).

This study used the co-integration methods, together with VECM, to analyse non-stationary data and to determine the existence of a long-run spatial relations between the urban and rural food markets.

6.3   Maize industry value chain overview

The South African maize industry was de-regulated in 1997. This marked the end of the agricultural commodity marketing board in South Africa. Deregulation was expected to increase the participation of many role players, especially small-scale growers and small agro-processing companies, who had been excluded by the single marketing channel. De-regulation led to the establishment of a new trading system in the maize industry, the South African Future Exchange (SAFEX). Currently, and since 1997, maize prices are determined under the free market system, with SAFEX being the main price

discovery mechanism for farmers, speculators and millers (Sturgess, 2010). Agro-processing companies are the major role players in the value chain for maize, as they convert raw maize into maize meal. Retailers and rural markets purchase maize meal products from agro-processing companies, or from wholesalers for re-sale to consumers.

There are four key industry retailers that sell food and non-food items in South Africa, namely Shoprite Checkers, Pink n Pay, SPAR and Woolworths. According to a Gauteng Treasury Report (2012), in terms of market share, Shoprite Checkers and Pink n Pay each have 30 % shares in the market. Although Pick n Pay and Shoprite Checkers have equal market shares, it appears that Shoprite Checkers have more stores (1 303) than Pick n Pay does. This makes Shoprite Checkers the leading retailer in South Africa. The market shares of SPAR, Woolworths and Massmart are 26 %, 11 % and 1 %, respectively. Given these market shares of the food industry retailers, it can be said that the South African food retailers have a concentration of ownership and operate as an oligopoly, where the action of one retailer leads to action change by the other retailers. However, in this study the interest was more on ascertaining the relationship between urban (retail) prices and rural prices for the same product, and further to analyse price differentials and price variability due to their impact on the affordability and availability of food.

6.4   Data and methodology used

Market price data for 2.5 kg super maize meal was used in this research. Data was acquired from the NAMC and Stats SA and it was from the period of November 2006 to July 2012. In analysing the data, aggregated rural and urban markets were used. The aggregated rural markets were represented by their provinces, namely the Free State (FS), North West (NW), Limpopo (LP), Eastern Cape (EC), Western Cape (WC), Northern Cape (NC), Mpumalanga (MP), Gauteng (GP), and Kwa-Zulu Natal (KZN). The aggregated urban market price data was represented by a variable called SA.

In the analysis of market price data, formal and informal methods were used to determine the nature of the time series and Eviews statistics package version 8.0 was used for data analysis. Informal methods involved the use of graphs, while formal methods involved the use of ADF to test unit root in the variables. The Johansen method was used to test for co-integration of variables, thus determining if the long-run relationship between the variables exists. Co-integration parameters were estimated through the use of VECM to establish dynamic effects between the markets, and non-integrated markets were estimated through the use of an ADL model.

6.5   Results of the study

The results of the study are comprised of two components, namely the industry performance analysis and an empirical analysis.

6.5.1   Industry analysis

In order to measure performance between urban and rural food markets, trend analysis, regression analysis, price spread (differentials) and price variability were used. The analyses conducted revealed the following:

- On average, the 2.5 kg super maize meal price continued to increase in South Africa (see Figure 11) over the period from November 2006 to July 2012. An upward trend with very less variations in the price of maize meal was observed, and the trend was found to be consistent with the general increases in the price of goods and services in South Africa.

- Comparatively, the prices of 2.5 kg super maize meal were found to be lower in provinces where there is high production potential of maize and in provinces where consumption of maize meal is lower. Urban market prices of maize meal were also found in the lower price categories. Higher prices were experienced in LP, EC, WC, MP and KZN provinces.

- The coefficients between urban and rural food markets were found to be higher (above 80 %). A statistically significant difference of 0.01 was found between urban and rural food markets mean prices. The null

hypothesis of no price difference was rejected. Although the coefficients were found to be higher than 80 %, it appears that provinces that produce maize in abundance, such as FS and NW, had lower price increases in maize meal. Maize meal prices were also found to be lower in the WC, NC and in the urban market (SA), as compared with other rural spatial food markets. Investigation further revealed that in areas where maize is not much produced, for example GP, prices were also not very high. This can be attributed to good infrastructure, such as processing facilities (which are located near cities), tarred roads, good communications, and distances to the markets which are shorter.

- Price variability analysis has revealed that provinces with lower maize production potentials exhibit high price variability in the 2.5kg super maize meal. The study established that MP rural markets have high price variability of white maize meal. This output was not astonishing because MP produces more yellow maize than white maize. High prices of maize meal in MP can be attributed to marketing agents' behaviour, and to problems in structural factors.

6.5.2   Empirical analysis

To measure spatial market relationships between urban and rural food markets, and to determine whether price transmission exists between the markets, ADF, Co-integration methods, the VECM, ADL and IRF were used. The model results are explained in the sections that follow.

6.5.2.1   *ADF and co-integration tests*

The ADF test results revealed that nine of the time series variables had a unit root, and one rural food market (NW) was found to be stationary at levels. Markets that showed non-stationary behaviour of the price series were subjected to co-integration tests.

Johansen co-integration tests revealed that six out of the nine markets were co-integrated with the aggregated urban market price. The null hypothesis of co-

integration could not be rejected for six of the aggregated rural markets. The probability values corresponding to the trace and max statistics were more than 1 %, 5 % and 10 % critical values of significance. This provided sufficient evidence that aggregated urban markets are co-integrated with aggregated rural markets. Co-integrated markets often show a long-term equilibrium relationship, although in the short run, deviations from the long-run equilibrium can occur. To establish the long-term relationships and price dynamic effects between the co-integrated markets VECM was applied.

6.5.2.2   *VECM and adjustment process*

The VECM test results revealed that all co-integration equations are negative and significant as expected. The probability values corresponding to the coefficients were very small and less than the critical values of 1 % and 5 % levels of significance. The null hypothesis of no long-run relationship is rejected. This means that the explanatory variable (SA) has a long-run causality effect on all the rural markets tested. The speed of price adjustment to the long-run equilibrium relationship was found to be faster, at 65 % on average, in the five markets and only one market showed a slower speed of 40 % to the price adjustment. The fast speed of price adjustment to long-run equilibrium relationship suggests that transaction costs have significant effects on the linkages between urban and rural food markets.

According to Goletti *et al*. (1995), rapid adjustments towards the long-run equilibrium give an indication of mechanism flexibility, and do not necessary indicate the good functioning of systems. However, from the speed of price adjustments analysis, it appeared that where the speed of price adjustment was lower, the time period was shorter. For example, in FS, the speed of price adjustment was approximately 40 % and it took about 2.46 months for prices to stabilise. With regard to the time period of price adjustment to the long-run equilibrium, the results show that it takes about three to five months for co-integrated markets to reach equilibrium.

6.5.2.3   Short run dynamic effects on co-integrated markets

According to the test results, there appears to be short run causality in some of the rural markets. The coefficient of SA lagged one (SA (-1)) caused the FS rural food market price to change in the short run. The joint probability value was found to be 0.046 in FS, and it is less than 5% and 10 % level of significance. Jointly, the coefficient of SA as shown by Wald test significantly caused prices of 2.5 kg super maize meal to change in FS in the short run. Similarly, the coefficient of SA lagged one (SA (-1)) also caused LP rural food market prices to change in the short run. The joint probability value was found to be 0.054 in LP and it is less than 10 % level of significance. This implies that in the short run, changes in the price of 2.5kg super maize meal in urban markets have the effect on rural food markets of LP. Other markets tested did not show short run dynamic effects and these included WC, NC, GP and KZN.

6.5.2.4   Short run dynamic effects on non-co-integrated markets

The study revealed that three markets, namely EC, MP and NW, were not co-integrated. When co-integration does not exist, only short-run dynamics effects can be determined. ADL model was applied to stationary data and the results show that there is a dynamic short-run effect between urban and rural food markets of the EC. The short-run dynamic effect was found to be significant at 1% level. This implies that in the short run, *ceteris paribus,* changes in the price of 2.5kg super maize meal in the urban markets lead to a price change in EC. This result was further confirmed by the joint co-efficient test in EC at 0.01 level of significant. Short-run dynamic effects in MP and NW were found to be insignificant.

6.5.2.5   Impulse response function in models

The responses explained here are those of FS from SA, and the other responses between markets locations are provided in Annexure 1 to Annexure 5. The IRF results show that after deviations have occurred in the market, prices converge to long-run equilibrium relationship. The results further show a period of between three and seven months for negative and positive shocks to be eliminated from the FS rural markets. The decrease and normalisation in

prices as showed in the market have implications for both traders and consumers. For example, a lower price of maize meal can be good for the consumers, but the challenge might be product availability in the rural market. This is because at lower prices of maize meal, traders might not have incentives to engage in trade and this might lead to distribution challenges for the traders.

Overall, the markets tested revealed a period of between two and eleven months for negative and positive shocks to be cleared in all the markets. The long period of dynamic price adjustment implies weak effect in the other rural markets and suggests that transaction costs have significant influence in the spatial market integration.

6.6 Conclusions and Recommendations

6.6.1 Main conclusions

This study focused on measuring spatial market integration between rural and urban food markets. The main objective of the study was to establish whether there exists market integration between rural and urban food markets.

The study revealed that out of the nine rural food markets which were measured for spatial price linkages, approximately six are co-integrated with urban markets. Integration tests further show that one rural market (NW) is stationary at level. VECM was applied to the co-integrated markets to establish speed and time of price adjustment to the long-run equilibrium, including determination of short-run dynamic effects. The results of the VECM show different speed and time of adjustments to the long-run equilibrium price. On average, the speed of price adjustment to the long-run equilibrium is approximately 65 % in five co-integrated markets. Only one market showed a slower speed (40%) of price adjustment. The time of price adjustment is between three and five months in the co-integrated markets. However, it was discovered that the slower the speed of price adjustment, the shorter is the time to adjust to long-run equilibrium.

The co-integration tests results revealed that EC and MP rural markets are not co-integrated with urban markets. This further includes NW, where market integration was not conducted owing to price data which are stationary at levels. Lack of market integration between the three rural markets (EC, NW and MP) suggests that the markets operate independently. This further suggests that households purchasing 2.5kg super maize meal are likely to face high food prices because of the lack of market information flow. Analyses of market performance have proved that maize meal is a bit expensive in rural EC and MP. The results suggest the problems of development in the rural space. The problems could be directly linked to structural factors and behaviours of market actors and to the policies as suggested by Goletti e*t al.,* (1995). However, further research need to be conducted to determine the exact factors that could be responsible for lack of market integration in the provinces identified. This is an important policy space for the development of rural areas and to solve the problems relating to food availability and affordability.

The short-run dynamic effect tests show that there are significant effects in FS, LP and EC rural markets. The joint probability value in FS is 0.046 which is less than 5% level of significant; in LP and EC the joint probability values were found to be 0.054 and 0.01, respectively. This probability values are less than 10 % levels of significance, implying that there exist short-run dynamic effects in the selected rural food markets. This means, *ceteris paribus*, changes in the price of 2.5kg super maize meal in urban food markets lead to changes in the price of the same product in the rural food markets. Short-run dynamic effects were found to be insignificant in MP, NW, GP, WC, NC, and KZN rural food markets.

Tests of market integration usually consider the extent to which shocks are transmitted among spatially separated markets (Goodwin & Piggott, 2001). The overall price shocks transmission from urban to rural food markets was found to be taking a period of between two and eleven months for negative and positive shocks to be eliminated in the markets. The long period of dynamic price adjustment implies weak effect in the other rural markets and suggests that transaction costs have significant influence in the spatial market integration.

Urban and rural food markets are supplied with maize meal products by wholesalers or agro-processing firms. There was no indication of markets importing or exporting 2.5 kg super maize meal from or to each other.

6.6.2 Recommendations and policy implications

The study recommends the following:

- The government should remove the bottlenecks that lead to lack of spatial market integration in the identified rural food markets. However, to be accurate on the factors associated with lack of spatial market integration further research required.

- Policy measures that aim at smoothening trade between urban and rural market are required. This will ensure that trader's access market signals as quickly as possible to make informed decisions that will allow a short time price transmission adjustment process.

- Further research into competitiveness of spatial market integration is needed. The research will establish if there is an element of uncompetitive market behaviour in the pricing of 2.5 kg super maize meal which might be making it challenging for markets to integrate.

- This study focused on spatial price relationships between urban and rural food markets. It will be beneficial to conduct similar studies that concentrate on different products. This will provide a broader picture of the price transmission process and relationships, and a gauge of the performance of markets.

- Co-integration and VECM methods were used in the analysis of spatial price transmission, an area for further research might be to employ other econometric analysis techniques, such as Threshold co-integration models, which can assist with the non-continuation of the speed of price adjustment to the long-run equilibrium.

REFERENCES

Abidoye, B.O. & Labuschagne, M. 2014. The transmission of world maize price to South African Maize market: A threshold co-integration approach. *Agricultural Economics* 45 (4): 501-512.

Alemu Z.G. & van Schalkwyk, H.D. 2009. *Market integration in Mozambican Maize markets.* Addis Ababa: OSSREA Publications.

Altman, M., Hart, T. & Jacobs, P. 2009. Household food security status in South Africa. *Agrekon,* 48 (4): 345-361.

Ardeni, P.G. 1989. Does the Law of One price really hold for commodity prices? *American Journal of Agricultural Economics,* 71(3): 303-328.

Aker, J. 2010. Information from markets near and far: Mobile phones and agricultural markets in Niger. *American Economic Journal: Applied Economics*, 2(3): 46-59.

Amir, F.M., Babar, H., Muhammad, S. & Fazal, B. 2011. *Testing the law of one price in gram markets of Pakistan.* PMAS-Arid Agriculture, Rawalpindi, Quaid e Azam University, Islamabad, Pakistan. [Online] Available from http://mpra.ub.uni-muenchen.de/30600/ [Downloaded: 12-03-2014].

Baffes, J. 1991. Some further evidence on the Law of One Price. *American Journal of Agricultural Economics, 73 (*4): 1264-1273.

Balke, N.S. & Fomby, T.B. 1997. Threshold cointegration. *International Economic Review*, 38(3): 627-645.

Bardhan, P.K. 1984. *Land, Labour and rural poverty: Essay in Development Economics.* Delhi: Oxford University Press.

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

Barrett, C.B., Li, J.R. & Bailey, D. 2000. Factor and product market tradability and equilibrium in Pacific rim pork industries. *Journal of Agricultural and Resource Economics*, 25(1): 68-87.

Barrett, C.B. 1996. Market analysis methods: Are our empirical toolkits well suited to enlivened markets*? American Journal of Agricultural Economics,* 77:825-829.

Baulch, B. 1997. Transfer costs, Arbitrage and Testing for food markets integration. *American Journal of Agricultural Economics,* 79 (2):447-487.

Bureau for Food and Agricultural Policy (BFAP). 2014. BFAP Baseline: Agricultural Outlook 2014-2023. African Food Systems. [Online] Available from www.bfab.co.za [Downloaded: 10-11-2014].

Buys, P. Deichmann, U. & Wheeler, D. 2006. *Road network upgrading and overland trade expansion in sub-Saharan Africa*. Washington, DC: Development Research Group, World Bank.

Coulibaly, S. & Fontagné, L. 2004. *South–South Trade: Geography matters*. CEPII Working paper, CEPII Research Centre, Paris.

Department of Agriculture Forestry and Fisheries (DAFF). 2012. Maize market value chain. Annual publication of the DAFF, Pretoria, RSA.

Department of Agriculture Forestry and Fisheries (DAFF). 2013. Abstract of Agricultural Statistics. Annual publication of the Department of Agriculture Forestry and Fisheries (DAFF), Pretoria, RSA.

Delgado, C. 1995. Types of transaction costs affecting agriculture in developing countries. A hand out given at the discussion of research design on income diversification and comparative advantage. Unpublished.

Delgado, C.L.1986. "A variance components approach to food grain market integration in Northern Nigeria" *American Journal of Agricultural Economics,* 68: 970-979.

Dickey, D. & Fuller, W.A. 1979. Distribution of the Estimates for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Association*, 74: 427-431.

Effiong, J.A.L. & Ayawari, D.T. 2005. Role of market information in the performance and spatial integration of grain markets in Kaduna State. *International Journal of Agriculture and Rural Development,* 6: 126-131.

Engle, R.F. & Granger, C.W.J. 1987. Co-integration and error correction: representation, estimation and testing. *Econometrica,* 55: 251-276.

Enke, S. 1951. Equilibrium among spatially separated markets: Solution by electrical analogue. *Econometrica,* 19: 40-47.

Fackler, P. & Goodwin B.K. 2001. Spatial price analysis, in Gardner, B.L. & Rausser, G.C. (eds). *Handbook of Agricultural Economics*. pp 971-1024. Amsterdam: Elsevier Science.

Fackler, P. 1996. Spatial price analysis: A methodological review. Mimeo, North Carolina State University.

Fama , E.F. 1970. Efficient capital markets. A review of theory and empirical work. *The Journal of finance*, 25 (2): 383-417

Food and Agricultural Organisation of the United Nations (FAO). 2004. *Price transmission in selected Agricultural markets*. FAO commodity and trade policy research working paper No.7. Rome: FAO.

Food and Agricultural Organisation (FAO). 2010. World Food Price Index. Monthly data commencing from January 1990 to July 2012.

Global Agricultural Information Network (GAIN). 2013. Report on the supply and demand for grains and feed in South Africa. Assessment of Commodity and Trade issues by the USDA. [Online] Available from http://gain.fas.usda.gov [Downloaded: 08-08-2014].

Gardner, B.L. & Brooks, K.M. 1994. Food prices and markets in Russia. *American Journal of Agricultural Economics*, 76: 641-646.

Gauteng Treasury. 2012. The Retail Industry on the rise in South Africa: Quarterly Bulletin, April-June 2012. [Online] Available from http://www.treasury.gpg.gov.za/Document/Documents/QB1%20The%20Retail%20Industry%20on%20the%20Rise.pdf [Downloaded: 18-07-2014].

GRAIN SA. 2013. South African maize export perspective, Perspective Newsletter. dated 14/06/2013. [Online] Available from www.grainsa.co.za [Downloaded: 18-07-2014].

Granger, C.W.J. 1981. Some properties of time series data and their use in econometric specification. *Journal of Econometrics*, 16: 121-130.

Goletti, F. & Babu, S. 1994. Market liberalization and integration of maize markets in Malawi. *Agricultural Economics*, 11: 311-324.

Goletti, F., Ahmed, R. & Farid, N. 1995. Structural determinants of market integration: The case of rice markets in Bangladesh. *The Developing Economies*, XXXIIII-2.

Gonzalez-Rivera, G. & Helfand, S. 2001. "The extent, pattern and degree of market integration: A multivariate approach for the Brazilian rice market*," American Journal of Agricultural Economics*, 83(3):576-592.

Goodwin, B.K. & Piggott, N. 2001. Spatial market integration in the presence of thresholds effects. *American Journal of Agricultural Economics,* 83:302-317.

Goodwin, B. K. & Schroeder, T.C. 1991. Co-integration tests and spatial price linkages in regional cattle markets. *American Journal of Agricultural Economics*, 73; 452-464.

Gujarati, D. N. & Porter, D. C. 2009. Basic Econometrics. The International 5th Edition. McGraw –Hill. Inc 1221 Avenue of Americans, New York.

Hernandez- Villafuerte, K. 2010. *The relationship between spatial price transmission and geographical distance: the case of Brazil*. Paper presented at the International EAAE-SYAL Seminar on Spatial dynamic in agri-food systems, Parma, Italy. 27th-30th October 2010.

Johansen, S. 1988. "Statistical analysis of co-integration vectors," Journal *of Economic Dynamics and Control*, 12: 231-254.

Karugia, J. T., Wambugu, S.K. & Oluoch-Kosura, W. 2003. *The role of infrastructure and government policies in determining the efficiency of Kenya's maize Marketing system in the post-Liberalization Era.* Research report submitted to IFPRI.

Kirimi, L., Sitko, N., Jayne, T.S., Karin, F., Muyanga, M., Sheahan, M., Flock, J. & Bor, G. 2011. *A farm gate to consumer value chain analysis of Kenya's maize marketing system*. MSU international development working paper, No 111. Michigan State University, East Lansing, Michigan, USA.

Knetter, M.M. 1993. International comparison of pricing to market behaviour. *American Economic Review,* June: 423-436.

Kohls, R.L. & Uhl, J.N. 1998. *Marketing of Agricultural Products*. 5th edition. New York: Macmillan.

Krugman, P. 1991. Increasing Returns and Economic Geography. *The Journal of Political Economy*, Vol 99, No. 3.pp483-499.

Lele, U. 1972. *Food marketing in India. Private performance and public policy*. Ithaca, New York: Cornell University Press.

Limao, N. & Venables A.J. 2000. Infrastructure, geographical disadvantage, transport and trade. *World Bank Economic Review*, 15(3): 451-479.

Lohano, H.D. & Mari, F.M. 2005. Spatial price linkages in regional onion markets of Pakistan. *Journal of Agriculture and Social Science*, 1(4): 318- 321.

Maize Tariff Working Group. 2005. A Submission of the Maize Tariff Working Group to the international Trade Administration Commission of South Africa (ITAC). [Online] Available from http://www.grainmilling.org.za/maize_tariff.htm [Downloaded: 01-09-2014].

McCray, B. 2011. Rural Small Business Trends. Small Biz Survival, The rural and small town business resource. [Online] Available from

http://www.cllm.org.au/PDFs/Projects/ONG/RuralSmallBizTrends2011.pdf. [Downloaded: 19-07-2015].

McNew, K. & Fackler, P.L . 1997. Testing market equilibrium: Is co-integration informative? *Journal of Agricultural Resource Economics,* 22: 191-207.

Medonza, M. & Rosegrant, M. 1991. Marketing of corn in Philippines: Market integration and the dynamics of price formation. In M Rosegrant & L. Gozalez (eds). *the Philippines corn livestock sector: Policy and performance.* Washington DC: International Food Policy Research Institute.

Mendoza, M. & Farris P.L. 1992. The impact of changes in government policies on economic performance (the ARCH Model). *Journal of Policy Modelling*, 14 (2).

Meyer, F.H. 2006. Model closure and price formation under switching grain markets in South Africa. Unpublished PhD thesis. University of Pretoria, RSA.

Meyer, J. 2003. Measuring Market integration in the presence of transaction costs. A threshold vector error correction approach. Contributed paper selected for the 25th International Conference of Agricultural Economists, August 16-22, Durban South Africa.

Minten, B. & Kyle, S. 1999. The effect of distance and road quality on food collection, marketing margin and trade wages: Evidence from the former Zaire. *Journal of Development Economics*, 60: 467-495.

Moodley, D., Kerr, W.A. & Gordon, D.V. 2000. Has the Canada-US trade agreement fostered price integration? *Review of World Economics,* 136: 334-354.

National Agricultural Marketing Council (NAMC). 2003. *Food Price Monitoring Committee Final Report.* A section 7 committee established under Marketing of Agricultural Products Act no 47 of 2006. Pretoria-RSA,

National Agricultural Marketing Council (NAMC). 2004. *Maize to maize meal value chain*, Analysis of selected value chains. Pretoria-RSA.

National Agricultural Marketing Council (NAMC). 2010. *Determining the factors that limit Agro-processing development in the maize milling industry in rural areas in South Africa*. Study compiled for MERC Division of the NAMC. Pretoria, RSA.

Negassa, A., Meyer, R. & Gabre-Maldhin, E. 2003. *Analysing grain market efficiency in developing countries: Review of existing, methods and extensions to the parity bound model.* Market and trade institutions. Discussion paper, No.63.

Osborne, T. 2005. Imperfect competition in agricultural markets: Evidence from Ethiopia. *Journal of Development Economics*, 75(3): 405-428.

Palaskas, T.B. & Harris, B. 1991. *Testing market integration: New approaches with case material from the west Bengal food economy*. Institute of Economic Analysis, Oxford, UK.

Penzhorn, N. & Arndt, C. 2002. Maize Markets in Mozambique: Testing for Market Integration. *Agrekon*, 41(2): 147-160.

Pindyck, R.O. 2004. Volatility and commodity prices Dynamics. *Journal of Food Marketing,* 24:1029-1047.

Rashid, S., Minot, N., Lemma, S. & Behute, B. 2010. *Are staple food markets in Africa efficient? Spatial price analyses and beyond.* Paper presented at Comesa policy seminar in Maputo, Mozambique. 25-26 January 2010.

Ravallion, M. 1986. Testing market integration. *American Journal of Agricultural Economics*, 68(1): 102 -109.

Robbins, P. 2000. *Commodity market information system: A general overview.* In proceed for a workshop on strategies for strengthening small scale farmer's food processing in the Eastern and Southern Africa. Entebbe, Uganda: CTA, Wageningen, The Netherlands.

South African Future Exchange (SAFEX). 2014. Spot price statistics for white and yellow maize. [Online] Available from: www.safex.co.za [Downloaded: 16-07-2014].

South African Grain Information Service (SAGIS). 2014. Supply and demand of white and yellow maize. Historic prices for domestic and international market. [Online] Available from: www.sagis.org.za [Downloaded: 16-07-2014].

Samuelson, P. A. 1952. Spatial price equilibrium and linear programming. *American Economic Review*, 42: 560-580.

Sen, A. 1981. Ingredients of famine analysis: Availability and entitlements. *The Quarterly Journal of Economics*, 96(3): 433-464.

Sexton, R., Kling, C. & Carman, H. 1991. "Market integration, Efficiency of Arbitrage and Imperfect Competition: Methods and Application of U.S. Celery." *American Journal of Agricultural Economics*, 7: 568-80.

Spiller, P. & Wood, R. 1988. "The Estimation of Transaction Costs in Arbitrage Models." *Journal of Econometrics*, 39: 309-326.

Staal, S. Delgado, C. & Nicholson, C. 1997. Smallholder dairy transaction costs in East Africa. *World Development*, 2(5): 779-794.

Sturgess, C. 2010. SAFEX Commodity Derivatives presentation. Johannesburg Stock Exchange (JSE), 11 October 2010.

Takayama, T. & Judge, G.G. 1964. Equilibrium among spatially separated markets: A reformulation. *Econometrica*, 32(4): 510-524.

Takayama, T. & Judge, G.G. 1971. *Spatial and temporal price allocation model*. Amsterdam: North-Holland.

Thompson, R.S., Sul, D. & Bohl, M. T. 2002. Spatial market efficiency and policy regime change: Seemingly unrelated error correction model estimation. *American Journal of Agricultural Economics*, 84: 1042-1053.

Tomek, W.G. & Robinson, K.L. 1995. *Agricultural product prices*. 3rd edition, Ithaca, London: Cornell University Press.

Tong, H. 1978. On a threshold model in the pattern recognition and signal processing. *World Bank Policy Research Working Paper 3358*. Washington DC: World Bank.

Vavra, P. & Goodwin, B.K. 2005. Analysis of price transmission along the value food chain. *Agriculture and Fishery Working Papers*, No.3, OECD Publishing.

Viju, C., Nolan, J. & Kerr, W.A. 2006. Common markets measuring integration in European Agricultural markets*. Review of European and Russian Affairs*, 2(1).

Vink, N. 2011. The role of DBSA in unlocking sustainable rural development in South Africa. Paper prepared for Development Bank of South Africa (DBSA), Mid Rand.

Vollrath, T.L. 2003. *North American agricultural market integration and its impact on the food and fibre system*. Agriculture information bulletin No. 784, USDA, USA.

Von Braun, J. 2008. *High and rising food prices: Why are they rising, Who is affected, How are they affected and What should be done?* Paper prepared for US Agency for International Development (USAID), Washington DC.

Weldegebriel, H.T. 2004. Imperfect price transmission: Is market power really to blame ? *Journal of Agricultural Economics*, 55: 101-114.

Wooldridge, J. F. 2013. Introductory Econometrics a Model Approach. International 5th Edition, South-Western Cengage Learning, Inc. USA.

Zachariasse, V. & Bunte, F. 2003. How are farmers faring in the changing balance of power along the food supply chain? OECD Conference: Changing dimension of food economy, Exploring the policy issues. The Hague, 6-7 February.

Zanias, G.P.1993. "Testing for integration in European community agricultural products markets" *Journal of Agricultural Economics*, 44: 418-427.

World Trade Atlas (WTA). 2014. Statistics on the export and imports of maize. [Online] Available from http://www.worldtradestatistics.com/gta [Downloaded: 07/30/2014].
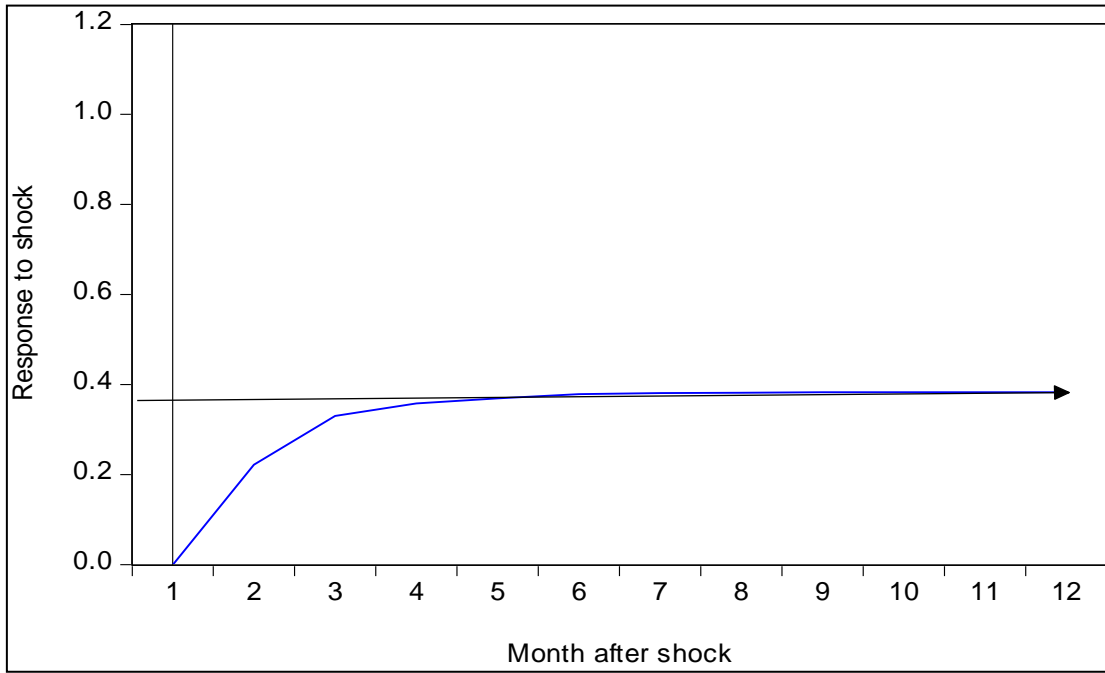
ANNEXURE:

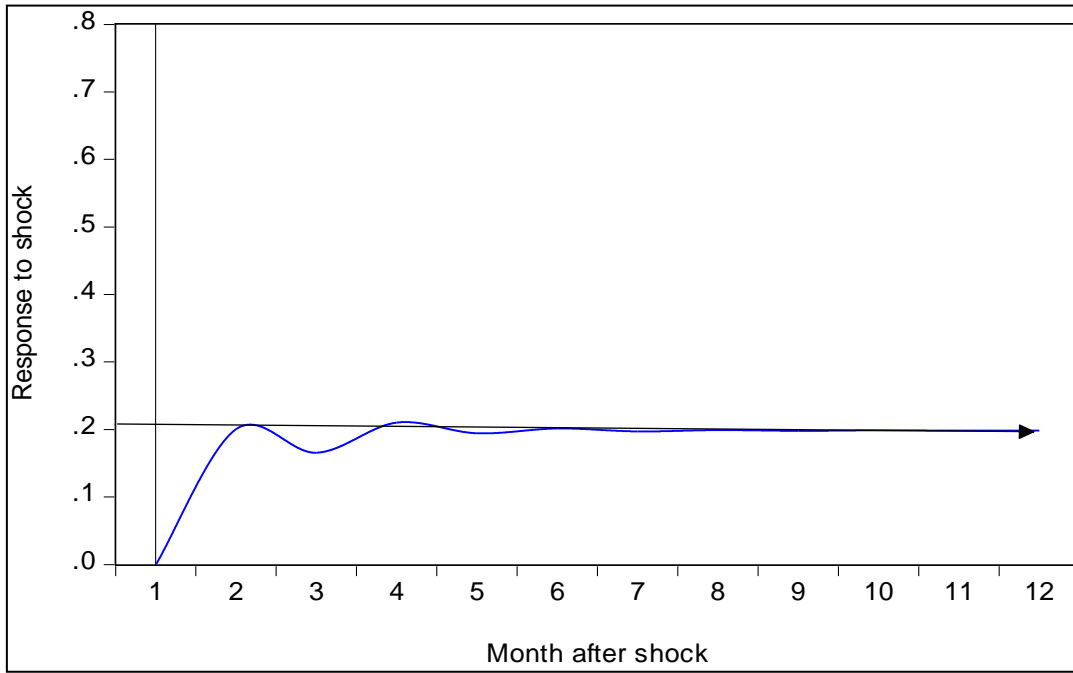**Annexure 1: Response of LP market from price shocks in SA market**
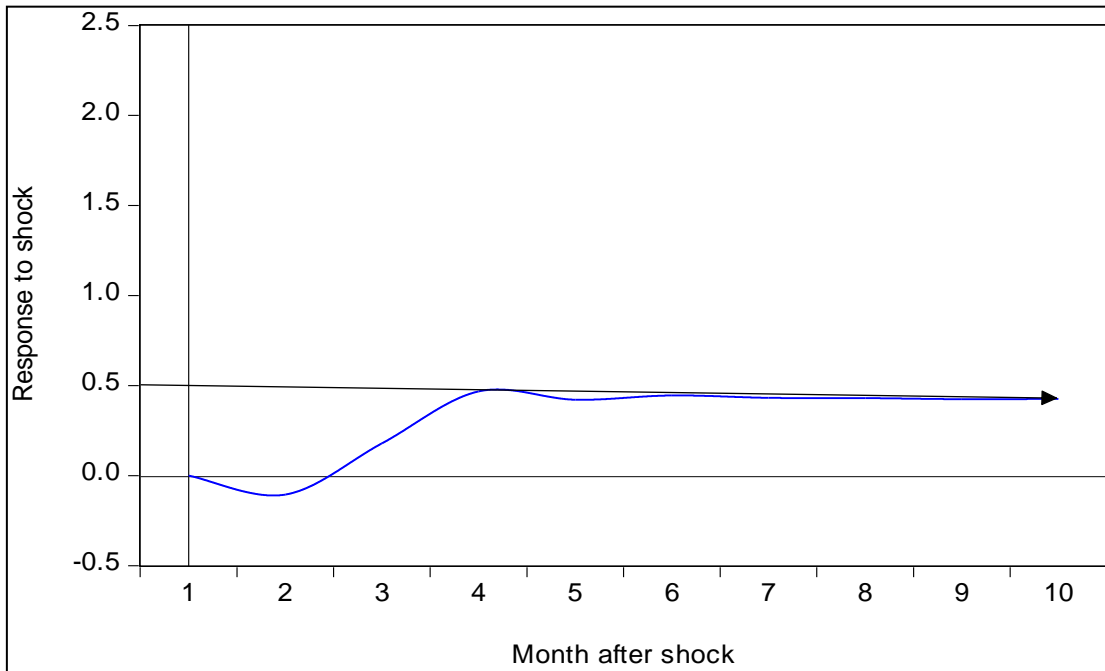
Source: NAMC, Stats SA, Author's computation

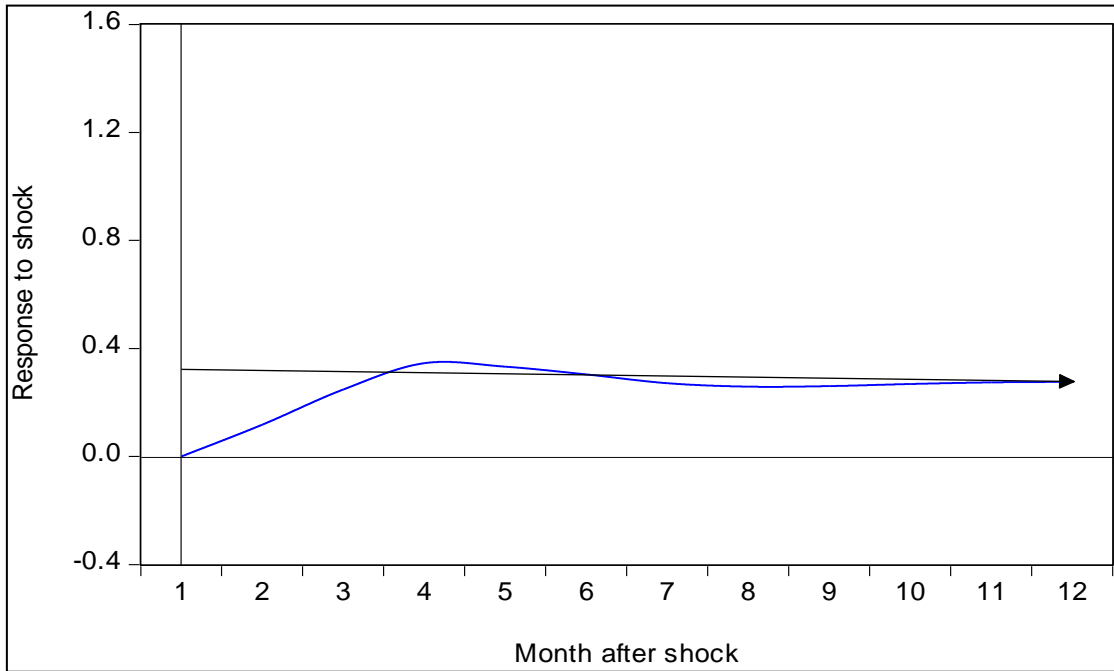**Annexure 2: Response of WC market from price shocks in SA market**

Source: NAMC, Stats SA, Author's computation

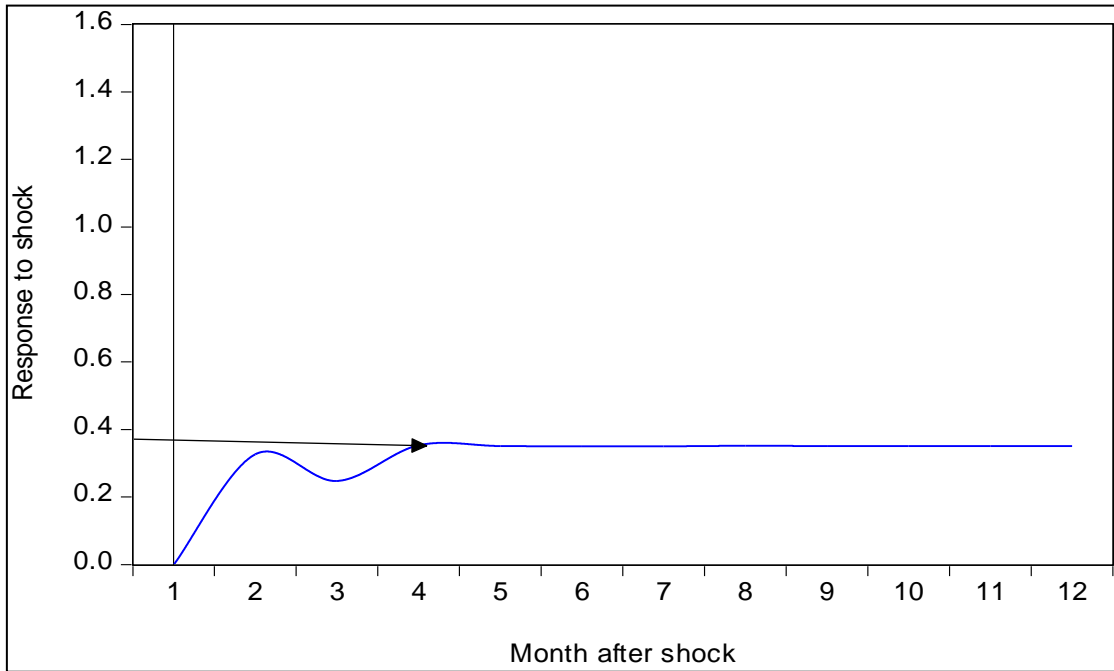**Annexure 3: Response of NC market from price shocks in SA market**

Source: NAMC, Stats SA, Authors computations

Annexure 4: Response of GP market from price shocks in SA market

Source: NAMC, Stats SA, Authors computations

Annexure 5: Response of KZN market from price shocks in SA market

Source: NAMC, Stats SA, Authors computations