ANALYSIS OF VERTICAL PRICE TRANSMISSION IN THE SOUTH AFRICAN POTATO MARKETS

BY

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DECLARATION

I, Mosese Douglas, hereby declare that the dissertation submitted to the University of Limpopo for the degree Master of Agricultural Management in Agricultural Economics has not previously been submitted by myself for a degree at this or any other university, that it is my own work in design and in execution, and that all the material used herein has been dully acknowledged.

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ABSTRACT

Potato is the most important vegetable crop in South Africa in terms of contribution to the gross value of agricultural production, export earnings and contribution to food supply base and food security in the SACU region. Despite the importance of this commodity, very little is known about the nature of price transmission between different levels of potato value chain in South Africa.

The study aims to determine the nature of price transmission in the South African potato market. The objectives of the study are to investigate the existence of long-run equilibrium relationship between producer, wholesale and retail prices; to determine characteristics of the relationship; and to determine the direction of price causality. The study made use of Error Correction Model and Granger Causality test.

The Empirical results reveal the existence of price asymmetry in the South African potato value chain. Furthermore, the results show that retail prices are more responsive producer price increases than they are to producer price declines. The Granger causality test shows that prices in potato value chain are determined mainly at the wholesale level (i.e. at the National Fresh Produce Markets).

The study recommends further research focusing on price transmission for other basic food commodities and that the government retains and strengthens the existing food price monitoring system.

Key word: Price transmission, vertical price transmission, price asymmetry, potato markets, potato value chain, fresh produce markets, potato prices.

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DEDICATION

This study is dedicated to my children, Reabetjwe Mosese and Voninga Mosese. I hope this study inspires them to always strive to empower themselves through knowledge.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ADF	Augmented Dickey Fuller unit root test
AIC	Akaike Information Criterion
APAC	Agricultural Produce Agents Council
DAFF	National Department of Agriculture, Forestry and Fisheries of the Republic of South Africa
DF	Dickey Fuller unit root test
ECM	Error Correction Model
ECT	Error Correction Term
EG	Engle and Granger approach
GDP	Gross Domestic Product
ITC	International Trade Centre
Joburg Market	Johannesburg Fresh Produce Market
lnFP	Natural Logarithm of Farm Price
lnRP	Natural Logarithm of Retail Price
lnWP	Natural Logarithm of Wholesale Price
NAMC	National Agricultural Marketing Council
NFPM	National Fresh Produce Markets
OLS	Ordinary Least Squares
Potato SA	Potato South Africa

PP	Producer Price
RP	Retail Price
SACU	Southern African Customs Union
SADC	Southern African Development Community
STATS SA	Statistics South Africa
SIC	Schwarz Information Criterion
VAR	Vector Auto Regressive Model
VRS	Vector Regime Switching model
WP	Wholesale Price

CHAPTER 1: INTRODUCTION

1.1. Background

Potatoes are the most important vegetable crop in South Africa and the world's most recognized stable food consumed by many people. It is grown in more than 125 countries and consumed almost daily by more than a billion people. In South Africa, the potato industry contributes approximately 57.7% to the total gross value of vegetable production, 11% to the gross value of horticultural products and 2.9% to the total value agricultural products (Department of Agriculture, Forestry and Fisheries (DAFF), 2016). Potato production also provides the livelihood for many and has notable multiplier effects up and downstream in the value chain (Du Preez, 2011).

Distribution of potato production in South Africa is segmented into 16 production regions (Potato South Africa, 2015). Limpopo is the biggest production region contributing 451 345 tons or 20% to South Africa's total potato production followed by Western Free State, Sandveld and Eastern Free State with 17%, 15%, and 14%, respectively. Limpopo and Free State provinces are very important to the South African potato industry. The production regions situated in these two provinces combined are responsible for about 66% of the country's total potato production (Potato SA, 2018).

Marketing of Potatoes in South Africa is segmented into five major channels, which include fresh produce markets, informal traders, processors, retailers, and export market. Over 51% of potatoes produced in South Africa are traded through national fresh produce markets while the remaining 49% is sold directly from farms to other channels such as processors, retailers and informal traders (DAFF, 2018). According to ITC Trade Map (2018), potatoes produced in South Africa are also exported to other countries, with the major export markets being Mozambique, Zimbabwe and SACU member countries such as Lesotho, Eswatini and Namibia.

Despite being the biggest vegetable crop in terms of the value of production, the potato industry makes a significant contribution to the economy in terms of export earnings, job creation and contribution to food security in the country. The industry also provides means of income generation for producers and plays an important role as a supplier of food to neighboring countries, especially the SACU member states (National Agricultural Marketing Council (NAMC) and Commark Trust, 2006; and Potato SA, 2018).

1.2. Problem Statement

The South African agricultural markets were deregulated in 1997 and became linked to the global markets where prices are determined by the market fundamentals such as demand and supply forces. In this open marketing environment, it is very important that role players have knowledge and understanding of the markets. One of the critical aspects to be knowledgeable about include commodity prices and evolution of the prices along value chains as this enables value chain players (i.e. producers, processors, retailers, and consumers) to anticipate possible price reactions at one level of value chain given changes of a certain magnitude at another level.

The subject of price transmission in the agricultural sector received lots of attention over the past decade. While so much price transmission studies were undertaken in recent years, only very little attention was focused on price transmission in the South African potato value chain. Du Preez (2011) undertook the only known study undertaken with a focus on price relationships in the South African potato market. The study was aimed at determining price relationships and spatial linkages between selected fresh produce markets in South Africa, and therefore they focus on horizontal linkages and price relations between markets that are on the same level of the potato value chain. There is therefore a knowledge gap concerning vertical price transmission in South African potato markets. Very little, if any, is known about the nature of price transmission between different levels of potato value chain in South Africa.

1.3. Rationale and scope of the study

DAFF (2015) identified potatoes as one of the priority commodities that have the capability and potential to create jobs and contribute to food security and growth of the sector. As noted in Food and Agriculture Organisation (FAO) (2008), potatoes are a primary source of protein for many of the world's poor. This implies that potato is even more relevant to South Africa and the entire African continent where economic development, job creation, and food security are the most important imperatives for the government and the entire population.

Just like most commodities in the agricultural sector, potatoes are traded in a free marketing environment that is characterized by price uncertainty and fluctuations. For the free market machinery to function very well the value chain players must be equipped with market information. The food marketing system is a system of communications, conflict resolution, and coordination. The system must transmit to buyers and sellers the information that is useful for decision-making. Such information must make it possible to achieve a compromise between the needs of producers and consumers, and it must provide incentives to encourage efficient decision-making (Kohls and Uhl, 2008). While the information on potato prices at different nodes of the value chain is readily available from different sources, there is very limited knowledge concerning the extent to which price swings at one node of the supply chain causes the up or downstream prices changes.

The adjustment of price shocks along the chain from producer to wholesale and to retail levels, and vice versa, is an important characteristic of the functioning of markets. For this reason, the process of price transmission through the supply chain has long attracted the attention of agricultural economists as well as policymakers. A common concern to policymakers relates to the assertion that, due to imperfect price transmission, a price reduction at the farm level is only slowly and partially transmitted through the supply chain (Vavra and Goodwin, 2005). It is also widely believed that price increases at the farm level are passed-through more quickly and fully to the final consumer.

This study determines how potato prices are transmitted from the farm through wholesale to the retail level. More specifically the study seeks to answer questions on how big is the response at retail level due to price shocks at the farm level, whether there are any significant lags in price adjustment, and whether the adjustments differ depending on whether the shocks are positive or negative. The answer to the above questions, which is what this study seeks to determine, will enable role-players within potato value chains to estimate with better precision how retail prices are likely to respond to the observed changes in farm and wholesale prices, and vice versa. This has the potential to improve decision making among value chain role-players such as producers, traders, policymakers, and consumers. The study therefore seeks to achieve the following aims and objectives:

1.3.1 Aim of the study

The aim of the study was to determine the nature of price transmission between different levels of potato value chain in South Africa. This will shed some light concerning the pricing behaviour of certain role-players in the potato markets.

1.3.2 Objectives of the study

The objectives of the study are to:

i. Investigate the existence of the long-run relationship between producer prices, wholesale prices and retail prices for potatoes.
ii. Determine the characteristics of the relationship between prices at different levels of the potato value chain.
iii. Determine the direction of price causality along the South African potato value chain.

1.4. Hypotheses

i. There is no long-run relationship between producer prices, wholesale prices and retail prices for potatoes.
ii. The relationship between producer, wholesale and retail prices for potatoes is symmetric.
iii. Potato prices are transmitted both down-stream (from farm to retail) and up-stream (retail to farm).

1.5 Structure of the report

Since the aim of the study is to to determine the nature of price transmission between different levels of potato value chain in South Africa, the next chapter focuses on review of literature related to agricultural markets, pricing, the concepts of price transmission as well as analytical approaches used in previous studies and recent findings in the area of price transmission. Chapter 3 presents overview of the South African potato industry. Chapter 4 covers description of methodology while chapter 5 presents results of the study. The last chapter (Chapter 6) presents summary, conclusion and recommendations of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews previous work undertaken in the areas of agricultural markets, market structure and pricing behaviour, time series analysis and price transmission. The underpinning theories pertaining price transmission, methodological issues and best practices for time series analysis are also reviewed. The attention is also given to historical evolution of price transmission methodologies, types as well as causes of asymmetry in price transmission.

2.2 Agricultural Markets and Price Relations

An efficient agricultural marketing system is a very important pre-condition for achievement of food security. In an efficient marketing system, producers are able to get reasonable prices without compromising the welfare of other value chain players such as consumers (Veselska, 2005). The extent of marketing efficiency depends heavily on the nature of market structure, market performance and market conduct. Market conduct refers to the behaviour of market agents in relation to price determination, sales promotion strategies and the regulatory activities of government. If market agents employ collusive tactics as part of their pricing strategy, this will lead to imperfect price transmission within the given market or between markets (Kanakaraj, 2010 and Antonova, 2013).

Price represents the equilibrium point where buyers and sellers meet in the market place. Availability of market information can alter the expectations of market participants and lead to new equilibrium prices as sellers revise their offer prices and buyers revise their purchase bids based on the new information. The speed and magnitude with which various role-players alter their price positions, and whether such price positions will ultimately become effective, depends mainly on the market structure within which a commodity is traded (Schnepf, 2006). Phuu (2016) and Schnepf (2006) identify the degree of market concentration as one most important attributes of market structure.

Economic theory suggests that the market structure affects pricing behaviour within markets. As noted by Edwards *et al.* (2006), the degree of market concentration is inversely related to the degree of competition. This is because, as noted in Cutts and Kirsten (2006), highly concentrated markets are normally dominated by small number of factories or intermediaries who are mostly very large and control the markets and prices through the greater share that they command as major buyers or sellers of certain commodities. These factories wield some degree of market power, which could be one of possible sources of asymmetry in food price transmission (Cutts and Kirsten, 2006).

The food value chains are generally less concentrated at the farm level compared to down-stream where the market concentration is brought about by the economies of scale that limits the number of viable role-players at wholesale, processing and retail sectors (Cutts and Kirsten, 2006). This implies that the down-stream intermediaries, who are mostly structured in an oligopolistic manner, might be better positioned to respond opportunistically to variety of price shocks than producers are. For example, oligopolistic intermediaries may react collusively much faster and with high magnitude to shocks that squeeze their profit margin than to shocks that stretch their margins (Cutts and Kirsten, 2006).

As noted above, the price represents a point where buyers and sellers reach consensus or compromise position with regard to the value of good and service at the time of exchange. The smooth running of food marketing systems depends mainly on coordination, communication and conflict resolution. The system must covey to buyers and sellers the signals on which to base their business decisions. It has also been noted that the extent of market concentration has a huge bearing on pricing behaviour and how various value chain players respond to price shocks. Highly concentrated markets are associated with more market power and less competition. Therefore, the fact that that food value chains are less concentrated at farm level and more concentrated down-stream, as noted in Cutts and Kirsten (2006), implies that the intermediaries might have more influence than farmers on the market outcomes such as prices.

2.3 Concept of price transmission

Agricultural Economists have for a long time been concerned with the transmission of market shocks between different stages of food value chains and between horizontally related markets. The literature on the subject dates back more than one hundred years and was typically concerned with spatial price relationships, *i.e.,* links between prices at different locations (Vavra and Goodwin, 2005).

Concepts pertaining to spatial price transmission are more applicable to theories associated with market integration. For example, Du Preez (2011) investigates market integration within potato industry in South Africa with specific focus on the existence of price relationship and spatial linkages between eight national fresh produce markets of South Africa and finds that the selected pairs of fresh produce markets are integrated in the long-run but are not integrated in the short run. In addition, Sunga (2017) finds a long run equilibrium relationship between Kasama and Mbeye dry bean markets in Eastern and Southern Africa. Sunga (2017) further finds that Lubumbashi and Kitwe markets are segmented. Although it is relevant from methodological and application viewpoints, spatial market relations is not primary focus of this study. The current study focuses primarily on vertical price transmission, which will be discussed further in the upcoming sub-section.

2.4 Vertical price transmission

Vertical price transmission deals with links between farm, wholesale and retail prices. The vertical price relationships have featured predominantly in recent studies as commodity markets have become increasingly concentrated at each level and integrated across levels (Vavra and Goodwin, 2005). Although vertical price transmission generally refers to the primary mechanism through which the different levels of supply chain are linked, in specific terms it is the process that reflects the relationship between vertical upstream and downstream prices (Uchezuba, 2010). In other words, vertical price transmission focuses on how prices at one level of the supply chain responds to price shocks at another level.

Vertical price relations are normally characterised by the magnitude, speed, nature and direction of the adjustment along the supply chain in response to market shocks that are generated at different levels of the marketing value chain. The magnitude of adjustment focuses on how big the response is at each level due to a shock of a given size at another level while the speed of adjustment is all about whether there is any significant lags in adjustment. In simple terms, the speed of adjustment deals with the question of how much time does it take for one level of the chain to respond to shocks of a given size at another level. On the other hand, the nature of adjustment deals with the question of whether adjustments at a given value chain level exhibit asymmetry following positive and negative shocks at another level. Lastly, the direction characteristic focuses on whether the adjustments differ depending on whether a shock is transmitted upwards or downwards the supply chain (Vavra and Goodwin, 2005).

2.5 Symmetry and asymmetry in price transmission

According to Uchezuba (2010), it is generally expected that a long-run equilibrium relationship should exist between upstream and downstream prices in a market that is vertically integrated. This implies that the prices of goods engaged in economic activity should reflect their scarce economic value in the long-run. In this case, reasonable market agents should be able to price their goods to a level that maximises their utility, while ensuring equitable distribution of economic welfare to consumers in the process (Veselska, 2005 and Uchezuba, 2010).

Based on the above, one would expect any external shocks to the upstream prices to generate short-run and long-run adjustments towards the long-run equilibrium. For example, as noted in Uchezuba (2010), increases or decreases in upstream prices should simultaneously trigger appropriate changes in the downstream price both rapidly and completely. This type of price relationship is known as symmetric price transmission.

Peltzman (2000) denotes that price asymmetry is a key feature of both competitive and oligopoly market structures. This implies that price asymmetry is more of a rule rather than exception in both highly and less-concentrated market structures. For this reason, asymmetric adjustment in the transmission of prices at various levels of food value chains has been of much empirical interest to agricultural economists for decades. Price asymmetry can be defined as un-reciprocal relationship between increases and falls in prices between different levels in the market value chain of a product (Acquah, 2012).

Asymmetric price responses are of concern to producers of agricultural products who often claim that retail prices rise faster and fuller than farm prices, and that retail price declines are unlikely to be either as full or as fast as declines in farm prices (Gauthier and Zapata, 2001). This argument is reaffirmed by several findings. For example, Acquah and Dadzie (2010) investigates asymmetric adjustment between retail and wholesale maize prices and find that the adjustment of retail price to wholesale price is faster when there is an increase in the wholesale price than when there is a decrease. In addition, other findings such as Cutts and Kirsten (2006); Goodwin and Holt (1998); Bor *et al.* (2014); and Bathla and Shrinivasulu (2011) also reveal that the retail prices adjust more quickly to increases in farm prices than to declines, implying serious welfare losses for consumers.

2.5.1 Types of Asymmetry

Meyer and von Cramon-Taubel (2002) identifies three criteria through which asymmetry in price transmission can be classified. The first criterion refers to a question of whether it is the speed or magnitude that leads to asymmetry. As denoted by Vavra and Goodwin (2005), the magnitude refers to the size of response at each level of value chain due to a shock of a given size at another level while the speed deals with the question of whether there are any significant lags in adjustment. The modalities of these criteria are illustrated further in Figures 2.1 and 2.2.

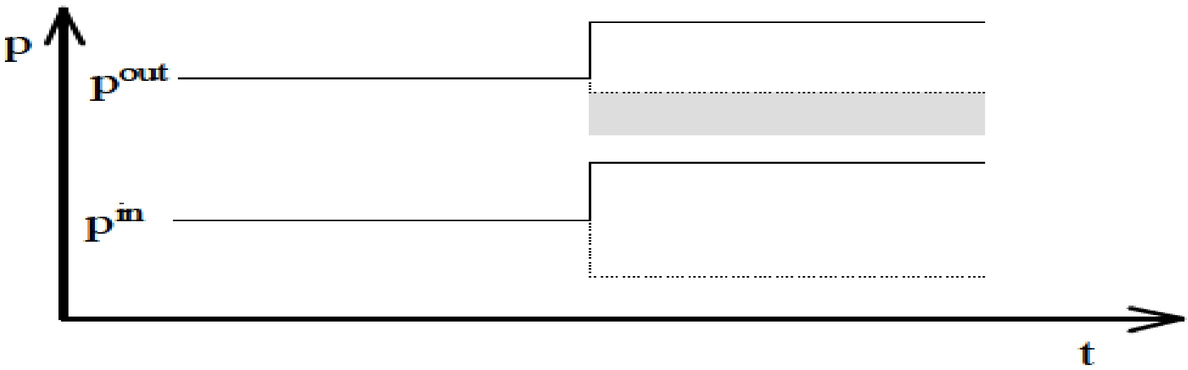

Figure 2.1: Asymmetric price transmission (Magnitude)

Source: Meyer and von Cramon-Taubel, 2002.

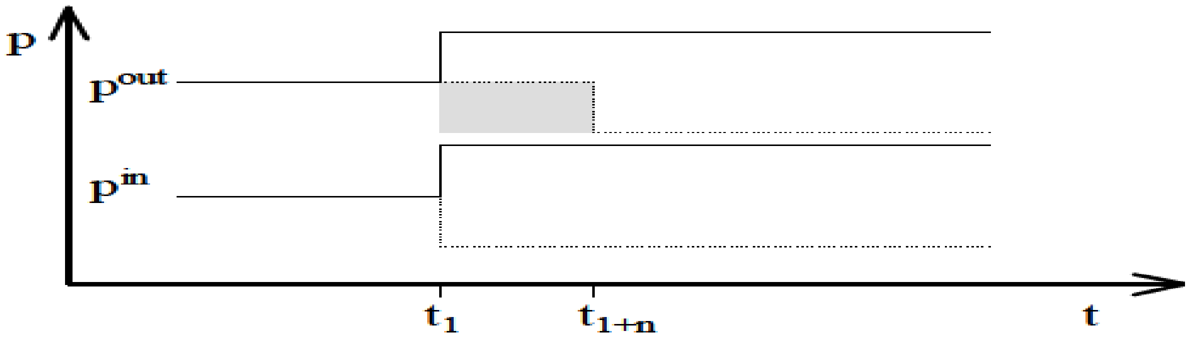

Figure 2.2: Asymmetric price transmission (Speed)

Source: Meyer and von Cramon-Taubel, 2002.

According to Figures 2.1 and 2.2 output price (P^{out}) is assumed to depend on input price (P^{in}) that either increases or decreases at a given point in time. In Figure 2.1, the magnitude of the response to a change in P^{in} varies depending on the direction of change. The P^{out} is more responsive to an increase in P^{in} than it is to a decrease. In the case of Figure 2.2, the speed of response by P^{out} depends on the direction of change in P^{in}. In this case, P^{out} responds immediately to an increase in P^{in} but takes longer to respond to a decrease in P^{in}. As observed from Figure 2.2, P^{out} responds to a positive change in P^{in} within time period "t_1" but takes time period "t_{1+n}" to respond fully to a downward change in P^{in} (Meyer and von Cramon-Taubadel, 2002).

The second criterion classifies asymmetric price transmission as either positive or negative. As noted by Peltzman (2000), the positive asymmetry refers to a phenomenon where output prices respond more fully or rapidly to a positive cost shock than to a negative cost shock. In other words, this represents a situation where input price increases are transmitted in a higher magnitude than input price decreases to the final price. On the other hand, the negative asymmetry is the opposite of positive asymmetry. The negative asymmetry is dubbed to occur when output prices respond more fully and/or rapidly to decreasing input prices than they do to increasing input prices. Although either positive or negative asymmetric price transmission may occur in different market structures, there is sufficient empirical evidence to suggest that the positive asymmetry is the most common of the two. For instance, *Guerrero et al.* (2005) investigates asymmetric price transmission in producer and consumer markets in Mexico and find that most markets present positive asymmetric price transmission. Similar findings were also made by other authors including Cutts and Kirsten (2006); Goodwin and Holt (1998), Bor *et al.* (2014), Bathla and Shrinivasulu (2011) and Peltzman (2000).

2.5.2 Causes of Asymmetry in Vertical Price Transmission

The subject of asymmetric price transmission has been the centre of attention from economic literature in recent years. The literature reveals that asymmetry in price transmission is a rule rather than an exception (Peltzman, 2000) and identifies several factors leads to asymmetry. Those factors include market power; perishability of goods; adjustment and menu cost; inventory management; search cost; and government intervention (Meyer and Von Cramon-Taubadel, 2004; Azzam, 1999; and Bailey and Brorsen 1989). These factors are discussed in detail in paragraphs that follow:

(a) Market Power

Most publications on asymmetric price transmission refer to market power or lack of competition as explanation for price asymmetry (Meyer and Von Cramon-Taubadel, 2002; Ward, 1982; and Bailey and Brorsen 1989). This notion is more prominent in agricultural sector where farmers at the top of the chain and consumers at the bottom-end often suspect that imperfect competition in the processing and retail sub-sectors allows intermediaries to abuse market power. This is generally expected to result is positive asymmetric price transmission (Meyer and Von Cramon-Taubadel, 2002). However, there exist some theoretical and empirical evidence that market power can also lead to negative asymmetric price transmission. For instance, Ward (1982) considered asymmetry in retail, wholesale and shipping point and found that market power can lead to negative asymmetry if oligopolists are reluctant to lose market share through price increases. This is likely to occur in instances where an individual oligopoly firm holds a view that other competing firms will match an increase in output prices as input prices increases but not a reduction as output prices fall (Bailey and Brorsen, 1989).

Although market power is often held responsible for imperfect price transmission, recent research demonstrates that this does not always have to be the case. Azzam (1999) demonstrate that price asymmetry can occur even in a competitive environment due to intertemporal optimizing consumption behaviour, so that prices may rise relatively more than decline in response to a corresponding direction of shocks in producer prices. McCorriston *et al.* (2001) also demonstrate that if the cost function is characterised by increasing returns to scale, the influence of market power might be offset by the cost effect of scale enlargement and the level of price transmission may increase relative to the competitive case.

(b) Perishability.

Because they have shorter shelf life, perishable products can limit the retailers' capability to adjust prices in accordance with adjustments in input cost. Ward (1982) points out that asymmetric price transmission is common in markets of perishable products because retailers might hesitate to increase prices as producer prices raise for the fear of losses that might result from spoilage and reduced sales. This phenomenon, as pointed out by Meyer and Von Cramon-Taubadel (2002) could result in negative asymmetry. Heien (1980) presents a different argument from what Ward put across. Heien points out that changing prices are hardly a problem for perishable products compared to those with a long shelf-life. This is because changing prices for commodities with long shelf-life is costly in terms of time taken to replace old price labels with new ones (menu cost) and in possible losses of goodwill.

(c) Adjustment and menu cost.

Based on findings from a number of studies (Reagan and Weitzman, 1982; Kovenock and Widdows, 1998; and Uchezuba, 2010), asymmetric price transmission may result from asymmetry in firms' adjustment costs with respect to increasing or decreasing prices. One example of adjustment cost that may result from price changes is the menu cost. Manu cost refers to the cost of changing nominal prices of goods, printing catalogues and dissemination of information about price changes (Uchezuba, 2010).

(d) Inventory management.

Ward (1982) suggest that downstream actors such retailers may be very slow in increasing output prices following an increase in input prices in order to facilitate continuous outflow of perishable products and to minimize spoilage risk from unsold products. On the contrary, Reagan and Weitzman (1982) argue that downstream actors may reduce their prices relatively slowly as an inventory management strategy that allows them to maintain stock because a more rapid price reduction could mean that their inventory would run out. The two contrasting views imply that using the price as a tool for inventory management can lead to either positive or negative asymmetry. If Reagan and Weitzman (1982) argument holds, then a decline in input price would result in a delayed and gradual output price adjustment relative to an increase in input price (Positive asymmetry). However, if Ward (1982) argument applies, then a decline in input price would be transmitted more rapidly and immediately to output price than would an increase in input price (Breseman, 2018). This represents a negative asymmetric price transmission phenomenon.

(e) Search Costs.

Another reason for asymmetric price transmission is the presence of search cost in imperfect local markets. The local grocery stores and other retailers may enjoy the local market power because other similar outlets do not exist in a particular area (Cutts and Kirsten, 2006). This implies that although customers may theoretically have number of choices, in reality they might not be able to gather sufficient information about prices offered by other retail outlets further away due to the cost involved in doing such a search. Cutts and Kirsten (2006) further argue that when customers experience price hikes at one retail chain, the consumer may not be sure whether other similar outlets have also increased their prices. Therefore, any intermediary who is aware of this predicament is likely to respond quickly by increasing their prices when upstream prices increase and slowly decrease their prices when upstream prices decline.

(f) Government intervention.

Gardner (1975) identifies government intervention such as producer price support initiatives as one of the causes of price asymmetry. Similarly, Kinnucan and Forker (1987) argue that government intervention that establishes a floor on farm prices for extended periods can in part reduce uncertainty associated with interpreting cost changes. The intermediaries may view farm price increases caused by higher price support policies as permanent increases in costs that may have been anticipated in advance. Under these circumstances, an increase in cost is likely to be transmitted rapidly and completely through the marketing system. Because reductions in price support levels occur less often, the intermediaries may view these effects as largely short-lived, resulting in a slower and incomplete price transmission (Gardner, 1975 and Kinnucan and Forker, 1987).

2.6 Recent studies concerning vertical price transmission

Measuring vertical price transmission along the food chain from producers to consumers has become a widespread means of evaluating the efficiency of and the degree of competition in food processing and marketing (Meyer *et al.,* 2006). Vertical price transmission became prominent in recent studies and received scrutiny from variety of authors including Louw *et al.* (2017), Lombard (2015), Bor *et al.* (2014), and Kinnuncan and Forker (1987).

Louw *et al.* (2017) analysed the impact of price determination and price transmission process on food inflation, with specific focus on the South African wheat-to-bread value chain and maize-to-maize meal value chain. The authors employ the time series econometric techniques such as vector error correction model (VECM) to determine how commodity prices evolve into final retail prices and the associated reasons for that. Louw *et al*. (2017) made a finding of full price transmission in the case of wheat-to-bread value chain, but incomplete transmission in the maize-to-maize meal value chain. The authors also found bi-directional transmission in the wheat-to-bread value chain, implying that prices in the wheat-to-bread value chain are determined at producer and consumer level. On the other hand, a unidirectional transmission was found in the maize-to-maize meal value chain with prices being determined at retail level and passed upstream through the chain to the producer level.

The findings by Louw *et al.* (2017) are thought provoking and can be interpreted in the context of the structures of the two value chains concerned. South Africa is generally a surplus producer and net-exporter of maize, and for this reason, the domestic maize producers tend to be price takers because they have to compete for the available market. On the other hand, the intermediaries/retailers are generally known to wield some level of market power (Cutts and Kirsten, 2006); hence they are a price determining point in the maize value chain. With regard to wheat, the phenomenon where prices are also determined at commodity level can be attributed to the fact that South Africa is a deficit producer of wheat hence producers also have a say on what wheat prices should be, although import prices have a huge bearing on domestic producer prices for wheat.

On the other hand, Lombard (2015) used the Error Correction Model to investigate price transmission in beef value chain in Bloemfontein (South Africa) and found the existence of long-run asymmetrical relationship between producer and retail prices for beef in that area. Price transmission in tomato markets also received attention. Mandizvidza (2013) investigated price transmission relationship between producer, wholesale and retail tomato prices in Limpopo Province of South Africa and arrived at the following findings: Through the uses of Granger causality test, Mandizvidza (2013) finds a causal link between producer and retail prices, and producer and wholesale prices for tomatoes in Limpopo Province. No causality could be established between wholesale and retail prices, meaning that wholesale and retail tomato prices were found not to be influencing one another. Ultimately, asymmetrical price transmission relationship was found between farm-gate and retail prices in that retailer were discovered to be quick to respond to increases in farm-gate prices and slow to adjust when farm decline (positive asymmetry). On the contrary, price transmission process between wholesale and farm-gate prices was found to be symmetrical (Mandizvidza, 2013).

Similar studies were also undertaken by a number of authors outside South Africa, and their findings are not significantly different from what was discovered by authors within the Republic. Kinnucan and Forker (1987) analysed farm-retail asymmetry for major milk products in United States of America (USA) and discovered that increases in farm prices for milk are passed-through to the retail more fully than farm price decreases. Similar findings were also made by Bor *et al.* (2014). Through application of Error Correction Model on the monthly fluid milk price data, Bor *et al.* (2014) found price asymmetry in the Turkish fluid milk market. Their findings reveal that milk prices at retail level tend to adjust more quickly to the input price increases than they do to the decreases input prices. Bor *et al.* (2014) ascribe this phenomenon to the fact that the market conditions allow retailers and processors to exercise significant market power and suggest that this may result in welfare losses on the part of consumers.

Acquah and Dadzie (2010) also found positive asymmetric price transmission between wholesale and retail prices for maize. In accordance with common belief, Acquah and Dadzie (2010) found that adjustment of retail prices to the wholesale price is faster when there's an increase than when there is a decrease. Although the literature suggest that the negative asymmetry is expected to be more prevalent in markets with highly perishable products, the cases of positive asymmetry are more prevent in recent studies. The cases of positive asymmetry were discovered for highly perishable products such as milk, tomatoes and products with longer shelf life such as maize (Bor *et al.,* 2014; Kinnucan and Forker, 1987; Acquah and Dadzie, 2010 and Mandizvidza, 2013).

2.7 Price transmission estimation method

2.7.1 Pre-cointegration models

Large number of studies have over the years focused on price transmission in agricultural markets. These studies used various techniques depending on questions to be addressed, the nature of data and the underlying assumptions. Tweeten and Quance (1969) used dummy variables technique to estimate irreversible supply functions. By means of dummy variables, the input price was split into two variables where one variable focuses only on increasing prices and the other on decreasing prices. Tweeten and Quance (1969) model was later adapted to the study of asymmetric price transmission by Wolffram (1971) by inclusion of variable splitting technique that include first differences of prices in the equation to be estimated. Houck (1977) and Ward (1982) made further enhancements to this technique to exclude initial observations and to introduce lags of the exogenous variables so that the delay in effect can be differentiated depending on whether the causal price is increasing or decreasing.

A reasonable number of studies have used the above-mentioned technique. For example, Kinnucan and Forker (1987) used a similar technique and discovered positive asymmetric price transmission in the U.S dairy market. Other studies that have explored the dummy variables approach include Price asymmetry in the US pork markets (Boyd and Brorsen, 1988), Price asymmetry in pork and beef (Hahn, 1990), Asymmetric price relationship in the US broiler industry (Bernard and Willett, 1996) and price asymmetry of fresh tomatoes in the U.S. Market (Girapunthong *et al.*, 2003).

Although the studies reviewed in the previous paragraph received much attention in agricultural economics field, it is noted with serious concern that these studies did not take into account the time series properties of the data. The negligence of time series properties of the data increases the risk of running regression analysis based on variables that are non-stationery and this, as noted by Meyer and Von Cramon-Taubadel (2004), may produce results that are spuriously significant. Such results will suggest the existence of relationships that in fact do not exist. Therefore, testing for non-stationarity and co-integrating relationship among price variables have become very important part of price transmission models.

2.7.2 Cointegration-based models

As indicated in paragraph 2.7.1, the greatest shortcoming of the non-cointegration models is that these models ignore the possible presence of a long rum equilibrium relationship in the data series. Granger and Newbold (1974) caution that running any econometric simulations based on variable that are random walks or near random walks is more likely to yield spurious relationships. Realising the need to evaluate time series properties of economic data, econometricians have developed tests for non-stationarity and methods for avoiding spurious regression that are generally known as cointegration analysis (Meyer and Von Cramon-Taubadel, 2004). Such tests and methods are explained in detail in paragraphs that follow.

2.7.2.1 Testing for stationarity

There exist several methods for testing stationarity of economic time series data. These include Dickey and Fuller's (DF) test and Augmented Dickey Fuller (ADF) test; Phillips-Parron test, Kwiatkowsky test, Phillips test and Schmidt and Shin test. Of all existing econometric tests, Augmented Dickey Fuller test is the most commonly used test due to its simple construction and feasibility (Arltova and Fedorova, 2016). During a comprehensive comparison of different techniques for unit root test, Arltorova and Ferdorova (2016) found ADF to be the most reliable technique due to the good results it produced. ADF yielded good results in cases of time series with both smaller and larger number of observations. In addition, Vavra and Goodwin (2005) also recommend the ADF as one of techniques to be used for testing of stationarity prior to estimation of price transmission model.

As noted by Vavra and Goodwin (2005), the null hypothesis for unit root test is that there is unit root (i.e. non-stationarity), with the alternative hypotheses of stationarity. A variable is said to be non-stationary if the value of its ADF statistics is smaller than the critical value, in which case the null hypothesis will be accepted. The null hypothesis is rejected if the ADF statistics is larger than the critical value. It must be remembered that the null hypothesis that the series possess unit root must be rejected if the estimated model is to be of any statistical significance (Vavra and Goodwin, 2005).

Flowing from the previous paragraph, the question therefore is, what happens if the ADF test results suggest acceptance of the null hypothesis? In other words, what happens if the data series are found to be non-stationary? The answer to this question is provided in Gujarati and Porter (2009), who suggest that the spurious regression problem, which may arise from regressing a non-stationary time series on one or more non-stationary time series, can be avoided by transforming the time series to make them stationary. The transformation method depends on whether the time series are difference stationary or trend stationary (Gujarati and Porter, 2009). The data transformation techniques to be considered in dealing with non-stationarity problem are discussed further in subsequent sub-paragraphs (a) and (b).

(a) Differencing

Differencing refers to a process of calculating the changes between each observation in the original series. If a time series has a unit root, the first differences of such time series are stationary (Gujarati and Porter, 2009). This implies that if the unit root is discovered in the data series, the regression analysis of the time series will have to be performed based on first differences of the original price data. The mathematical formula for differencing is adapted from Gujarati and Porter (2009) as follows:

$\Delta Y_t = (Y_t - Y_{t-1})$ (equation 2.1)

Subsequent unit root tests on differenced series provide guidance with regard to the form in which the data may be utilized in regressions. First differences of the series are often stationary, in which case the series is said to be integrated of order one (I(1)) and no further differencing is required.

(b) De-trending time series

Another way of dealing with non-stationary time series data that has trend is to regress it on time and the residuals from this regression will then be stationary. The regression equation for de-trending is recommended in Gujarati and Porter (2009) as:

$Y_t = \beta_1 + \beta_2 + u_t$ (equation 2.2)

Where Y_t is the time series under study and t is the trend variable measured chronologically.

Therefore:

$\hat{u} = (Y_t - \hat{\beta}_1 + \hat{\beta}_2 t)$ (equation 2.3)

Will be stationary. $\hat{u}$ is known as a linearly de-trended time series.

2.7.2.2 Testing for cointegration

When time series are found to be integrated of order I(0), I(1), I(2) etc., the next step should be to perform cointegration tests to determine whether long-term relationship exist among the variables (von Cramon-Taubadel, 1998). Testing for cointegration is a very important step in price transmission analysis as it helps to check if the model reveals empirically meaningful results and it aids the decision on which model to use in the estimation of price transmission. Several test methods for co-integration exist including the likes of Durbin-Watson (DW) method, Engle and Granger (1987) procedure, and Johansen test of cointegration.

Although all the aforementioned co-integration tests are relevant and can be applied individually depending on circumstances, Engle and Granger (EG) remains the most commonly applied procedure for co-integration test. The EG test's greatest advantage is that it is spontaneous and easy to perform (Sjö, 2008). Despite its popularity, Engle and Granger approach, as noted by Lombard (2015), falls short because of its symmetry and linearity assumption. The second shortfall originates from the fact that EG models assume a common factor in the dynamic system. Therefore, if the common factor assumption does not hold, the test can perform badly.

The Johansen test for cointegration is considered a more superior test as it has most, if not all, desirable statistical properties. The test is based on the notion that economic variables are much more likely to be endogenously interdependent. The presence of at least one co-integration relationship is necessary for the analysis of long-run relationship to be credible (Du Preez, 2011).

The Johansen's test makes use of two test statistics, namely the Eigen statistic and Trace statistic (Vavra and Goodwin, 2005). This maximum likelihood ratio test involves a reduced rank regression between two variables, say I(1) or I(0), providing *n* Eigen values $\hat{\lambda}_1 > \hat{\lambda}_2 > \cdots > \hat{\lambda}_n$ and corresponding eigenvectors $\hat{v} = (\hat{v}_1 \ldots \hat{v}_2)$, where the r

elements of $\hat{v}$ are the co-integration vectors. The magnitude of λ_i is a measure of the strength of correlation between the co-integrating relations for i =1 … r. The test of the null hypothesis that there are r co-integrating vectors present can be stated as:

H_0: $\lambda_i = 0$ $\qquad$ $i = r + 1 \ldots \ldots n$

The maximal-Eigen Statistics is given by:

$$\lambda_{max} = -T \log(1-\hat{\lambda}_{r+1}) \qquad r = 0, 1, 2, \ldots \ldots, n-1 \qquad (2.4)$$

Where T is the sample size and $(1-\hat{\lambda}_{r+1})$ is the Max-Eigen Statistic estimate.

The trace statistic is given by:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \log(1-\hat{\lambda}_i) \quad r = 0, 1, 2, \ldots \ldots, n-1 \qquad (2.5)$$

Testing the null hypothesis of r co-integrating vectors against the alternative of r+1.

The cointegration test is very important for price transmission studies given the fact that the results thereof will provide guidance on which econometric model would be the most appropriate to estimate the nature of relationship between the data series. For example if the price variables are found to be co-integrated in the long run, the most appropriate model to estimate price transmission will be the Error Correction model (ECM), which, as suggested by Hamdi and Sbia (2012), will correct the disequilibrium in the cointegration relationship and test for long and short-run causality among cointegrated variables. In the absence of any cointegration relationship other econometric specifications such as Vector Autoregressive Model may be of relevance.

Johansen test has been used extensively in recent history to test the long-run cointegration relationship in the time series analysis in recent history. Mandizvidza (2013) used the same test and found the long-run cointegration relationship between farm prices for tomatoes, and wholesale and retail prices of the same product. In the study of short-run and long-run causality between electricity consumption and economic growth in Belgium, Hamdi and Sbia (2012) also used Johansen cointegration tests and found the existence cointegration relationship between the data series. Because of cointegration relationship identified in the data series, both authors (Mandizvidza, 2013 and Hamdi & Sbia, 2012) decided to use the Error Correction Model to test price asymmetry in their respective data series.

2.7.3 Estimating price asymmetry

Different methods for testing asymmetry in price transmission are applied by various authors depending on the objectives to be addressed and the nature of data used. Frey and Manera (2007) proposes Vector Auto-Regressive (VAR), Vector Regime Switching (VRS) and Vector Error Correction as some of the models to be considered in price asymmetry analysis.

According to Frey and Manera (2007), the Vector Autoregressive (VAR) model is one of the most successful, flexible, and user-friendly models for the analysis of multivariate time series. The VAR model has proven to be very useful in describing the dynamic behaviour of economic and financial time series. The VAR model was deployed in Radchenko (2005) to evaluate the relationship between oil price volatility and the degree of gasoline price asymmetry. The author constructed three measures of oil price volatility and 12 measures of gasoline price asymmetry and examined the impulse response functions of gasoline price asymmetry to a shock in oil price volatility and found that there is a robust negative relation between oil price volatility and the asymmetry of gasoline price. On the other hand, Shepherd (2004) also used the multivariate VAR model to explain the relationship between producer and world prices for coffee in Brazil, India, Mexico, Colombia, Guatemala and Uganda.

It must be noted that the VAR model can only be plausible if there is no cointegration or long-term equilibrium relationship between the underlying data series (Binh, 2013). The econometric theory recommends the use of other models to investigate relationships between economic variables that have cointegration. Engle and Granger (1987) suggest, in a ground-breaking theory commonly referred to as Granger representation theorem, that if two variables Y and X are cointegrated, the relationship between the two can be expressed as Error Correction Model (ECM).

The application of Error Correction Model to price transmission analysis dates back to as far as Manning (1991), who focused on price transmission between crude oil and petrol. After deploying the Engle and Granger's (1987) two-step approach on the monthly data for brent crude oil and retail price for gasoline covering the period January 1973 to December 1988, the author finds that petrol prices react asymmetrically to changes in spot crude prices in the short-run. However, the author further notes that the asymmetry is short-lived and is virtually eliminated after a period four months. The same technique with an asymmetric specification is also used in von Cramon-Taubadel (1998) where asymmetry is found between producer and wholesale prices for pork in Northern Germany.

The ECM was also widely used by other authors to explain the relationship between variety of time series variables. These include Mandizvidza (2013), Radchenko (2005), and Bachmeier and Griffin (2003). Based on the literature reviewed thus far, asymmetry in price adjustment mechanisms appears to be a rule rather than an exception. This can be ascribed to causal factors such as market power, perishability, adjustment cost, inventory management and government intervention (Heien, 1980; Reagan and Weitzman, 1982; Ward, 1982; Kinnuncan and Forker, 1987; Bailey and Brorsen, 1989; and Meyer and von Cramon-Taubadel, 2002). The only known finding of symmetry thus far is in Mandizvidza (2013) who finds that wholesale prices are symmetrical with farm prices for tomatoes in Limpopo Province of South Africa.

2.8 Summary

This chapter reviewed previous work undertaken in the areas of agricultural markets, market structure and pricing behaviour; time series analysis; and price transmission. The underpinning theories pertaining price transmission, methodological issues and best practices for time series analysis as well as findings of recent relevant studies were also reviewed. It was noted that analysts use variety of econometric models to study price transmission, including the non-cointegration techniques that are not recommended because of their nature of neglecting time series properties of the data. The cointegration models such as Vector Autoregressive (VAR), Regime Switching (RS) and Error Correction (EC) models are recommended. The latter (i.e. the EC model) appears to be the most commonly used model in recent studies. In addition to its popularity in agricultural price analysis studies the ECM also has prominence in studies concerning Brent crude oil and gasoline price transmission.

CHAPTER 3: THE SOUTH AFRICAN POTATO INDUSTRY OVERVIEW

3.1 Introduction

This chapter provides brief overview of the South African potato industry. Specific attention in this chapter is afforded to the production volumes for potatoes in South Africa, the contribution of the South African potato sector to the total supply base in SADC and SACU regions. The chapter also includes contribution of potato industry to the economy of South Africa in terms of contribution to GDP, employment and export earnings. Different production regions as well as marketing channels for potatoes are also reviewed.

3.2 Production and sales

South Africa plays a huge role in terms of contribution to potato supply in the Southern African Development Community (SADC). The South African potato industry contributes 34.4% to SADC region's total potato production and 93.61% to the total supply in the SACU region (FAO, 2018). According to DAFF (2018), the production quantities for potatoes in South Africa ranges between 1.6 million tons and 2.3 million tons per annum and over 51% of the country's total potato crop is sold through the national fresh produce markets. Figure 3.1 shows that production volumes for potatoes has been on a steady increasing trend from 1999/2000 production season until 2016/17 production season. It is also notable that the sales volume follows the same trend as production trends, which is a clear indication of the South African potato industry's reliance fresh produce markets as a channel for distribution of potatoes in South Africa.

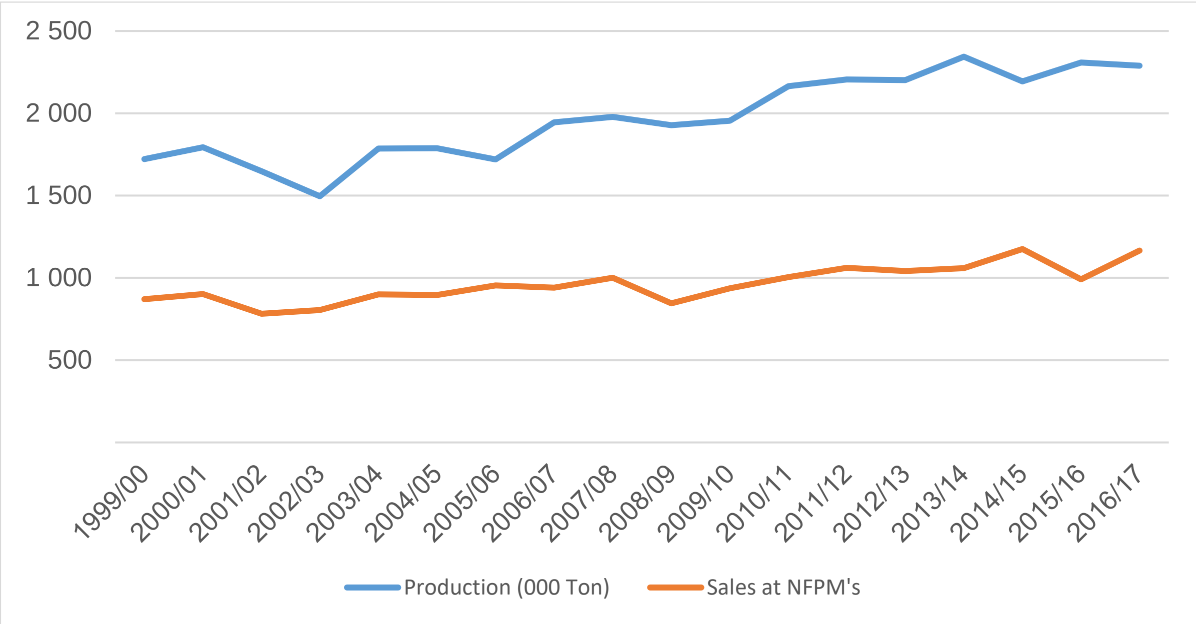

Figure 3.1:Potato production and volumes sold at National Fresh Produce Markets

Source: DAFF, 2018.

According to Potato South Africa (2015), distribution potato production in South Africa is segmented into 16 production regions. The production quantities in all regions and contribution of region to the total annual domestic production are presented in Figure 3.2. According to Figure 3.2 Limpopo is the biggest production region contributing 451 345 tons or 20% to South Africa’s total potato production followed by Western Free State, Sandveld and Eastern Free State with 17%, 15% and 14%, respectively. Limpopo and Free State provinces are very important to the South African potato industry. The productions regions in these two provinces combined are responsible for about 66% of the country’s total potato production with the rest of the remaining provinces being responsible for only 34% as presented in Figure 3.2.

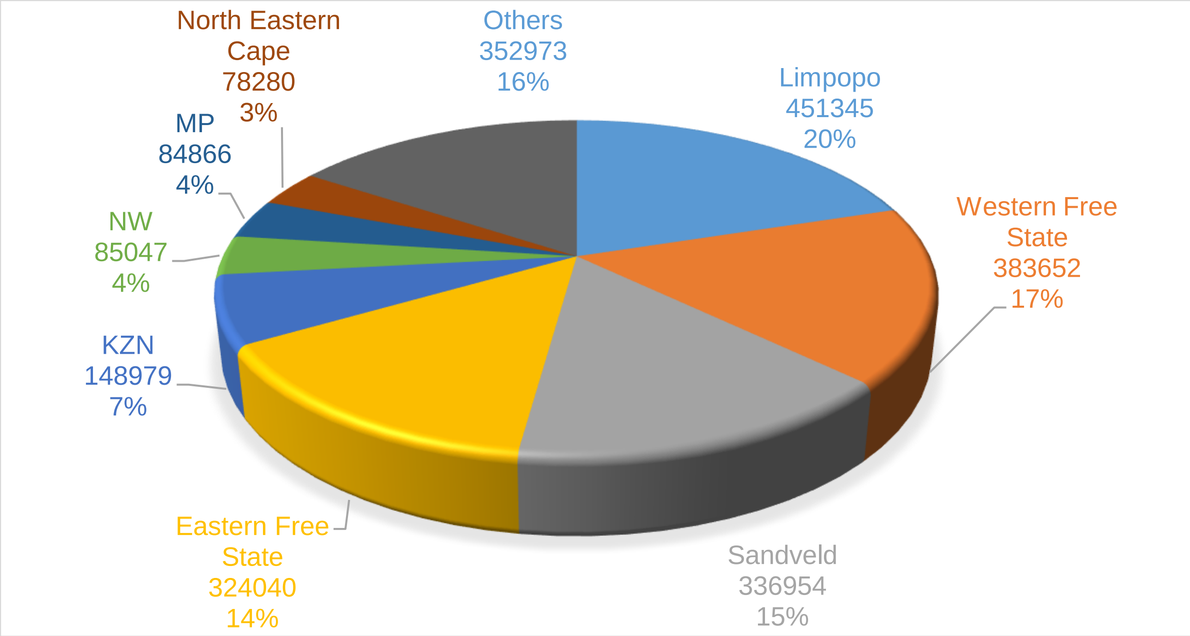

Figure 3.2: Production regions for potatoes

Source: User computation based on Potato SA data, 2015

3.2 Marketing Channels

The major marketing channels for potatoes in South Africa include fresh produce markets, processors, informal traders, export market and retailers. Figure 3.3 shows schematic representation of distribution channels for potatoes in South Africa. According to DAFF (2018), a total of 51% of South Africa's total crop for 2017 was traded through fresh produce markets. The remaining 49% was traded directly by producers to other channels such as retailers, processors, exports, informal traders and consumers.

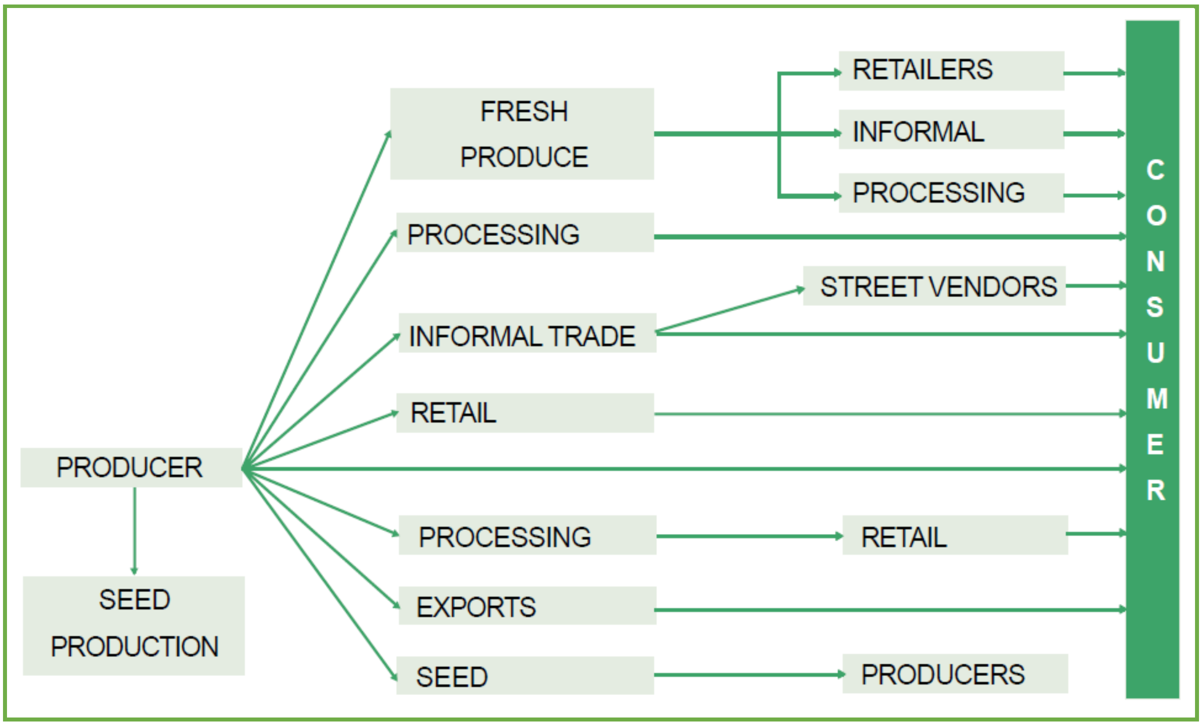

Figure 3.3: Distribution channels for potatoes in South Africa

Source: NAMC and Commark Trust, 2006.

3.2.1 Processing

In the processing sub-sector, potatoes are processed into variety of final products. Many potato processors procures potatoes directly from farmers through contract farming arrangements. In some instances, the processors also buy first grade potatoes from fresh produce market to supplement their raw material in the event where contract producers are not able to meet the volume requirements of the processor (NAMC and Commark Trust, 2006). According to Potato SA (2015), about 20% of total table potatoes produced in South Africa are sold directly from farms to the processing sub-sector in order to be processed into variety of processed products.

3.2.2 Informal trade

Informal traders who are commonly known as hawkers also play a major role in distribution of potatoes in South Africa. The hawkers normally buys potatoes in 10kg bags from fresh produce markets and repackage them into smaller packaging and sell directly to consumers in the townships. Informal traders purchased 65% of the total potato volume sold at the National Fresh Produce Markets in South Africa in 2018. The market share of the informal sector has been as a result of an increase in the number of an increase in the number of people entering the informal trade sector to make living from the trade in fresh produce (Potato South Africa, 2019).

3.2.3 Fresh produce markets

The National Fresh Produce Markets are an important part of price determination mechanism, distribution and marketing of fresh produce in South Africa. There are 18 commission-based National Fresh Produce Markets (NFPM) in South Africa, with Johannesburg Fresh Produce Market being the largest market in terms of annual turnover with the market share of 35% (NAMC and Commark Trust, 2006). The Johannesburg fresh produce market is also a leading/reference market for other markets in South Africa as far as determination of potato prices is concerned (du Preez, 2011). Although there are several markets that are operated privately, in general NFPMs are mostly owned and operated by the Local Authority (i.e. Municipalities). NFPMs are an integral part of the price-discovery because of the transparent nature of the trading system in this marketing channel. The prices are negotiated and agreed upon on the market floor between buyers and agents, and at the close of business the Market Management publishes sales volumes and prices at which commodities were traded on the day (Mosese and Hoyi, 2018). The schematic representation of the functioning Fresh Produce Marketing channel is presented in the Figure 3.4.

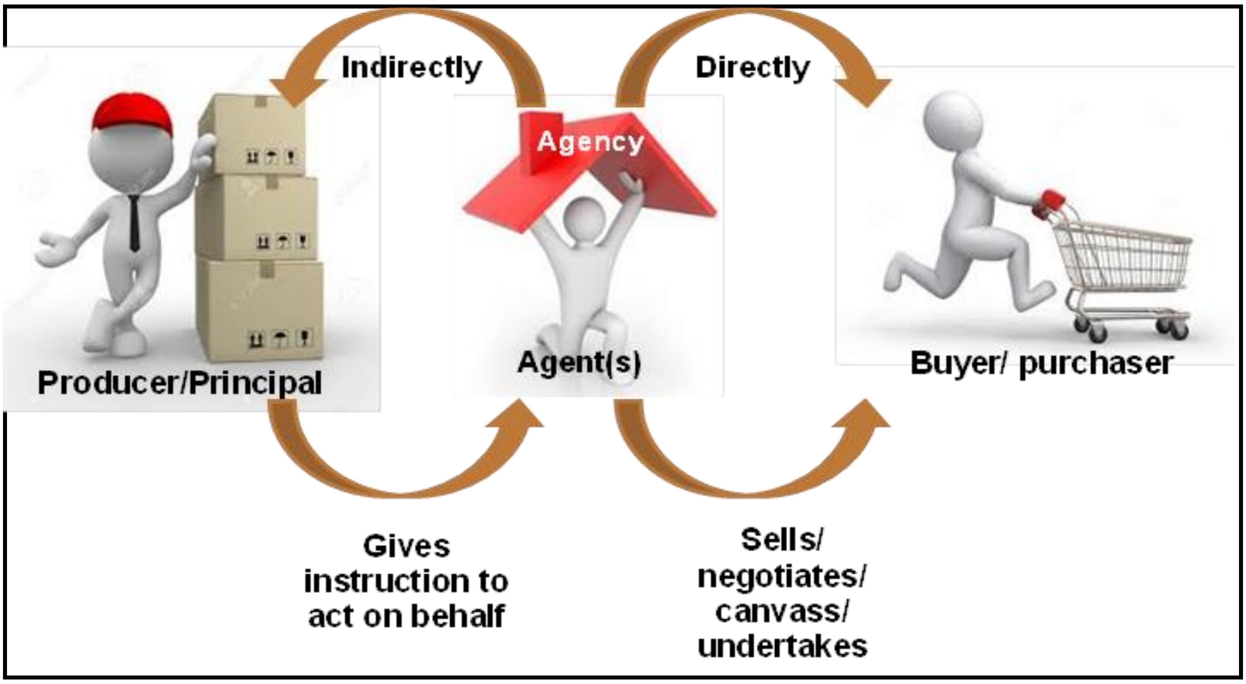

Figure 3.4: Functioning of the fresh produce markets in South Africa
Source: APAC (2016).

Figure 3.4 identifies three role-players within the trading system of fresh produce markets, namely the producer, market agent/agency and the buyer. The ultimate goal of the producer is to get the product to the kitchen of the consumer, but in most of the cases the producer is always too busy on the farm and does not have time to go around looking for consumers/buyers. On the other hand, it is not convenient for the buyer to drive around farms looking for vegetables. The Market Agents who mostly operates in the fresh produce markets are there to bring the producer and the buyer together. The producer delivers the product to the agent to sell on his behalf and, because the agents receive variety produce from farmers/producers and because the markets are mainly situated in the cities, the buyers find it convenient to buy from the fresh produce markets where they can find variety of products on the market floor (Mosese and Hoyi, 2018).

As noted by du Preez (2011) and DAFF (2018), fresh produce markets play an important role in distribution of potatoes in South Africa. The fresh produce markets distributes 51% of potatoes produced in South Africa to a variety of traders and end users. According to Potato South Africa (2019), informal traders are the biggest buyers of potatoes at the fresh produce markets. The proportions of the total potatoes distribution from fresh produce markets to various categories of buyers are presented in Figure 3.5. Informal traders purchased about 66% of the total potato volumes sold at the national fresh produce markets while the formal buyers such as retailers and processors are responsible for 23% and 6%, respectively. The national fresh produce markets export only 5% of the total potato sales to other countries (Potato SA, 2019).

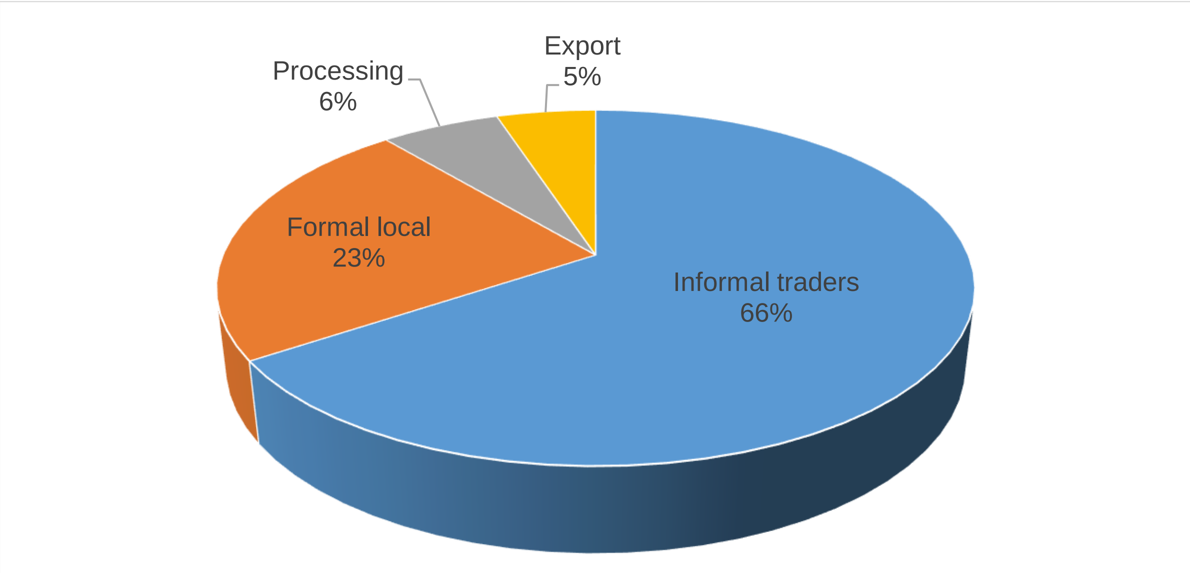

Figure 3.5: Buyers of potatoes at the National Fresh Produce Markets.

Source: Potato SA, 2019.

3.2.4 Exports

According to ITC Trade Map (2018), South Africa is the second largest exporter of potatoes on the African continent after Egypt, having exported 157 549 Tons of potatoes in 2018. On a global level, South Africa is ranked number 16 in terms of the value of potato exports. The biggest exporter of potatoes globally is Netherlands who is responsible for 19.6% of global potato exports in value terms followed by France and Germany with 15.6% and 9.1% respectively. The destination markets for potatoes exported from South Africa are presented in Table 3.1.

Table 3.1: List of main importing markets for potatoes exported by South Africa

Importers	Value exported in 2018 (USD thousand)	Trade balance 2018 (USD thousand)	Share in South Africa's exports (%)	Quantity exported in 2018 (Tons)	Unit value (USD/unit)
World	51 384	51 348	100	157 549	326
Mozambique	16 620	16 620	32.3	70 993	234
Namibia	8 679	8 659	16.9	21 253	408
Botswana	8 277	8 277	16.1	19 554	423
Zimbabwe	4 791	4 791	9.3	7 120	673
Lesotho	3 366	3 366	6.6	10 488	321
Angola	2 750	2 750	5.4	6 217	442

Importers	Value exported in 2018 (USD thousand)	Trade balance 2018 (USD thousand)	Share in South Africa's exports (%)	Quantity exported in 2018 (Tons)	Unit value (USD/unit)
Eswatini	2 063	2 054	4	11 635	177
Zambia	1 857	1 857	3.6	4 266	435

Source: ITC Trade Map, 2018.

As noted from Table 3.1, Mozambique is the biggest export market for potatoes exported by South Africa followed by Namibia and Botswana. About 32.3% of South Africa’s total value of exports originates from purchases made by Mozambique while Namibia, Botswana and Zimbabwe account for 16.9%, 16.1% and 9.3% of South Africa’s total potato export earnings. In addition, it is notable from Table 3.1 is the fact that the Zimbabwean importers paid a huge price to import a ton of potatoes from South Africa in 2018 compared to other importers. The per unit price of potato exports from South Africa to Zimbabwe amounted to USD673/ton. The countries that paid the lowest price to import potatoes from South Africa are Eswatini and Mozambique with per unit value of USD177/ton and USD234/ton, respectively.

3.3. The Significance of South African potato industry

Potato is South Africa’s most important vegetable crop and the world’s most recognized stable food consumed by majority of world population (DAFF, 2017). According to DAFF (2018), the primary potato production sector alone contributes between 6.28 and 7.41 billion Rand to the South African Economy. The inclusion of processing and other downstream value adding activities elevates the total value of potato industry per annum (Potato SA, 2018). As noted by DAFF (2017), the primary potato production sector contributes 52% to the gross value of vegetable production, 10% to the value of horticulture production and 3% to the overall gross value of agricultural production. Potato is also the most consumed vegetable crop in South Africa with per capita consumption ranging between 32.39 and 38.26 kg per year (DAFF, 2018).

Potato production provides means for income generation for producers and farm workers and has multiplier effects both up and downstream in the value chain. Potato production is a highly labour-intensive industry and employs 10% of South Africa's labour force involved in agricultural production (Potato SA, 2018). NAMC and Commark Trust (2006), potato farming sector requires 66 000 labourers annually in order to produce potatoes on between 50 000 hectares and 55 000 hectares that are normally planted in South Africa per season.

The South African potato industry also plays a role as the earner of foreign currency for the South Africa economy. South Africa exports about 500 thousand tons to potatoes per annum attracting foreign currency to the tune of about R500 million per year (DAFF, 2017). In addition, the local potato industry also serves as the major supplier of food to the neighbouring countries. According to ITC Trade Map (2018), Mozambique together with SACU countries such as Namibia, Botswana, Lesotho and Eswatini procure more than 96% of their potato import requirements from South Africa. Detailed information about South Africa's contribution to neighbouring countries' total potato imports is provided in Table 3.2.

Table 3.2: Imports of potatoes by South Africa's neighbouring countries in 2018

	Total imports	Imports from SA	SA's share in importer's total imports
Importers	Ton		%
Mozambique	7 758	7 734	99.6
Namibia	21 404	21 253	98.6
Botswana	20 055	19 544	96.5
Lesotho	10 488	10 488	100
Eswatini	11 635	11 635	100

Source: ITC Trade Map, 2018.

3.4 Summary

South Africa plays an integral part in potato production on the African continent, being the biggest producer in SADC and SACU regions. Most of potato production in South Africa occurs in Free State and Limpopo. Fresh produce markets are the major distribution channel for potatoes produced in South Africa. About 51% of local production is sold through fresh produce markets. Johannesburg market is the biggest fresh produce market in South Africa with an overall market share 35%. Johannesburg market also serve as a reference point against which other markets and traders benchmark prices for fresh produce. Potato is the most important vegetable crop in South Africa based on its contribution to gross value of agricultural production, export earnings and food security in neighbouring countries. South Africa is the second largest exporter of potatoes on the African continent after Egypt.

CHAPTER 4: METHODOLOGY

4.1 Description of study area

The study focused on price transmission along potato value chain in the Republic of South Africa. Potato production in South Africa is divided into 16 production regions, which jointly produce between 1.6 million and 2.3 million tons of potatoes per annum on 50 to 55 hectares of land (Potato SA, 2018). South Africa has a population of 57.73 and the per capita consumption is estimated to be ranging between 32.39 and 38.26 kg per annum (Statistics South Africa (Stats SA), 2018). The South African potato industry was selected for this study because of the significant contribution made by the South African potato industry to the value of agricultural production, export earnings and employment creation. The choice for potato is also guided by the contribution South Africa makes to potato supply base in the Southern African Development Community (34%) and the Southern African Customs Union (93.61%) (FAO, 2018).

4.2 The data set

This study used monthly average price data focusing on three variables, namely producer prices, wholesale prices and retail prices for unprocessed potatoes. The data covers 96 monthly observations ranging from January 2010 until December 2017. The data on producer prices was obtained from commodity statistics database of Food and Agriculture Organisation of United Nations (FAO) while data on retail prices was obtained from Statistics South Africa. The data on retail prices was obtained from Statistics South Africa. The monthly average prices for potatoes in Johannesburg

Fresh Produce Market were used to represent wholesale prices for the rest of the country. This is because Joburg Market is the biggest market in the country and also due to the fact that Joburg market is considered the price setter for potatoes in South Africa (du Preez, 2011). The data on wholesale prices was obtained from the Directorate: Economic Analysis and Statistics at the Department of Agriculture, Forestry and Fisheries.

4.3 Research design

The research design adopted was time series analysis where variety of analysis techniques were used to test and analyse time series data on producer, wholesale and retail prices for potatoes so as to determine the nature of vertical price transmission in the South African potato markets. This design was necessary in order to consider, based on time series properties of the data, the appropriate model for the analysis of how prices of potatoes are passed-through from one level of value chain to the other.

4.4 Data analysis technique

This section focuses on data analysis techniques that were used in the study to determine the nature of price transmission in the South African potato markets. These include testing the data series for stationarity through the use of Augmented Dickey-Fuller test; utilization of Johansen's Co-integration test to test for existence of the long-run co-integration relationship in the data series; as well as estimation of the Error Correction Model.

4.4.1 Conceptual framework

Generally, the rationale for measuring the extent of vertical price transmission is based on concerns that there are some imperfections in food markets, which leads to incomplete or delayed pass-through of prices from one level of value chain to the other. Therefore the philosophy of price transmission analysis is to use econometric analytical techniques to arrive at results that would either confirm or reject these concerns.

As it is the case with other time series-based analysis, it is very important that price transmission analysis be preceded by evaluation of time series properties of the data. Therefore, the analysis in this study started-off by employing Augmented Dickey-Fuller unit root test and Johansen co-integration test to evaluate the time series properties of the data. These tests, as noted by Vavra and Goodwin (2005), are useful for the purpose of putting the results into the context of the larger body of research and in order to consider appropriate model for price transmission.

The procedure then followed the two-step approach as specified by Eagle and Granger (1987): firstly, a co-integrating relationship between variables was estimated by using ordinary least squares (OLS), which was followed by estimation of Error Correction Model (ECM) by using lagged residuals from co-integrating regression as error correction terms. A detailed analytical procedure is specified in the sections that follow.

4.4.2 Augmented Dickey-Fuller (ADF) unit root test

Non-stationery variable tends not to go back to mean value over time. If prices are non-stationery, regression analysis will give misleading results. For example, regression analysis might suggest the existence of a statistically significant relationship even when there is, in fact, no relationship. Augmented Dickey-Fuller procedure that was applied to test stationarity of price variables in this study takes the form given by equation 4.1

$$\Delta P_t = \alpha + \boldsymbol{\beta} t + \varnothing P_{t-1} + \sum_{i=1}^{K} \Theta_i \Delta P_{t-1} + \mathcal{E}_t \qquad (4.1)$$

Where, P_t stands for potato price at time t at a certain stage of value chain (i.e. farm gate, wholesale or retail), and $\Delta P_t = P_t - P_{t-1}$;

- α = an intercept term,
- β, *Ø,* Θ are coefficients
- t = a term trend,
- k = maximum lag order to be determined, and
- $\mathcal{E}_t$ = a stochastic non-auto correlated error term with zero mean and a constant Variance.

The null hypothesis for unit root test is that there is unit root (i.e. non-stationarity), with the alternative hypotheses of stationarity. A variable is said to be non-stationary if the value of its ADF statistics is smaller than the critical value, in which case the null hypothesis will be accepted. The null hypothesis is rejected if the ADF statistics is larger than the critical value.

4.4.3 Johansen's Co-integration test

The Johansen's co-integration test was used in this study to determine the existence of co-integrating relationship among all test variables. The test is based on the notion that economic variables are much more likely to be endogenously interdependent. The presence of at least one co-integration relationship is necessary for the analysis of long-run relationship to be credible (Du Preez, 2011).

The Johansen's test makes use of two test statistics, namely the Eigen statistic and Trace statistic. This maximum likelihood ratio test involves a reduced rank regression between two variables, say I(1) or I(0), providing *n* Eigen values $\hat{\lambda}_1 > \hat{\lambda}_2 > \cdots > \hat{\lambda}_n$ and corresponding eigenvectors $\hat{v} = (\hat{v}_1 \ldots \hat{v}_2)$, where the r elements of $\hat{v}$ are the co-integration vectors. The magnitude of λ_i is a measure of the strength of correlation between the co-integrating relations for $i = 1 \ldots r$. The test of the null hypothesis that there are r co-integrating vectors present can be stated as:

$H_0: \lambda_i = 0 \qquad i = r + 1 \ldots \ldots n$

The maximal-Eigen Statistics is given by:

$\lambda_{max} = -T \log(1-\hat{\lambda}_{r+1}) \qquad r = 0, 1, 2, \ldots \ldots, n-1$ (4.2)

Where T is the sample size and $(1-\hat{\lambda}_{r+1})$ is the Max-Eigen Statistic estimate.

The trace statistic is given by:

$\lambda_{trace} = -T \sum_{i=r+1}^{n} \log(1-\hat{\lambda}_i) \quad r = 0, 1, 2, \ldots \ldots, n-1$ (4.3)

Testing the null hypothesis of r co-integrating vectors against the alternative of r+1. The Johansen co-integration test was very important for this study given the fact that the results thereof would provide guidance on the econometric model to use in the estimation of price transmission between producer, wholesale and retail levels of potato value chain.

4.4.4 The Model

This study used the Error Correction Model (ECM) to determine how prices are transmitted between farm gate, wholesale and retail levels of the value chain. The initial step towards estimation of error correction model is to estimate the co-integration regression using OLS in accordance with Engle and Granger (1987) approach. The general representation for OLS model is given by equation 4.4:

$$Yt = \alpha + \beta xt + v_t \qquad (4.4)$$

Where: y_t is the dependent price in time t (e.g. retail price)

x_t is the explanatory price in time t

α, β are co-efficients

v_t represents the error term

If y and x are I(1) then the residual v_t from the regression of those series would also be I(1), unless they are cointegrated. Thus if the residuals are I(1) we accept the null hypothesis of non-cointegration, but if the residuals are I(0) then we reject the null and accept that y and x are cointegrated.

After estimation of the cointegration regression model in equation 4.4, the Error Correction model was estimated by using lagged residuals of the regression equation as Error Correction Term. The standard notation for Error Correction Model takes the form presented in equation 4.5:

$$\Delta Yt = \alpha_1 + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + \sum_{j=0}^{k} \emptyset_j \Delta X_{t-i} + \alpha_2\, ECT_{t-1} + \varepsilon_t \qquad (4.5)$$

Where $ECT_{t-1} = U_{t-1}$ (lagged residuals from the cointegration relation regression between X and Y). Because of the need to account for asymmetry in this study, equation 4.5 was modified in accordance with Granger and Lee (1989) procedure into equation 4.6, in which the lagged cointegration equation residuals "U_{t-1}" are split into positive and negative components:

$$\Delta Yt = \alpha_1 + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + \sum_{j=0}^{k} \text{Ø}_j \Delta X_{t-i} + \alpha_2^{+} ECT_{t-1}^{+} + \alpha_2^{-} ECT_{t-1}^{-} + \varepsilon_t \quad (4.6)$$

Where: ECT_{t-1}^{+} = positive error correction term lagged by one period; and

ECT_{t-1}^{-} = negative error correction term lagged by one period.

In this study the price asymmetry was tested on three levels, namely farm-to-retail transmission, wholesale-to-retail and wholesale-to-farm. The error correction model applied in this study is presented in the section that follows.

(i) Farm to retail price transmission

$$\Delta lnRPt = \alpha_1 + \sum_{i=1}^{k} \beta_i \Delta lnRP_{t-i} + \sum_{j=0}^{k} \text{Ø}_j \Delta ln FP_{t-j} + \alpha_2^{+} ECT_{t-1}^{+} + \alpha_2^{-} ECT_{t-1}^{-} + \varepsilon_t \quad (4.7)$$

Where; $\Delta lnRPt$ represents first differenced *ln*RP in period (t)

$\beta_i \Delta lnRP_{t-i}$ represent lagged first differenced values of *ln*RP and its value in period (t)

$\sum_{j=0}^{k} \text{Ø}_j \Delta ln FP_{t-j}$ denotes lagged first differenced values of *ln*FP and its value in period (t)

RP_t and FP_t refer to retail and farm prices, respectively, during the period (t).

ECT_{t-1}^{+} = positive error correction term lagged by one period

ECT_{t-1}^{-} = negative error correction term lagged by one period

$\alpha_1, \beta_i, \text{Ø}_j, \alpha_2^{+}, \alpha_2^{-}$ are estimated coefficients

(ii) Wholesale to retail price transmission

$$\Delta lnRPt = \alpha_1 + \sum_{i=1}^{k} \beta_i \Delta lnRP_{t-i} + \sum_{j=0}^{k} \text{Ø}_j \Delta ln WP_{t-j} + \alpha_2^{+} ECT_{t-1}^{+} + \alpha_2^{-} ECT_{t-1}^{-} + \varepsilon_t \quad (4.8)$$

Where; $\Delta lnWPt$ represents first differenced *ln*WP in period (t)

(iii) Wholesale to farm price transmission

$$\Delta \ln FPt = \alpha_1 + \sum_{i=1}^{k} \beta_i \Delta lnFP_{t-i} + \sum_{j=0}^{k} \text{Ø}_j \Delta ln WP_{t-j} + \alpha_2^{+} ECT_{t-1}^{+} + \alpha_2^{-} ECT_{t-1}^{-} + \varepsilon_t \quad (4.9)$$

The empirical results emanating from the analytical procedure outlined in this section are presented in the section that follows.

4.5 Summary

This chapter described the methodological approach, comprehensive outline of research design used in this study and provided conceptual framework for analysis of vertical price transmission. Specifically, the focus was mainly on description of study area, the data set and the data analysis technique. The importance of testing time series properties of the data prior to undertaking price transmission analysis was noted. The Error Correction Model was presented as the most appropriate model for the study due to existence of co-integration relationship.

CHAPTER 5. RESULTS

5.1 Introduction

This section focuses on presentation and comprehensive interpretation of results of the study based on the sample of 96 observations of producer, wholesale and retail prices. The chapter starts-off by looking at time series properties of the data where the outcomes of unit root and cointegration tests are presented. The second subsection of the chapter deals with the outcomes of Granger Causality test where the causal relationship between variables is determined. The third and the fourth subsections provides estimates of cointegration regression equations and error correction model, respectively.

5.2 Data properties

5.2.1 Stationarity test

The stationarity and non-stationarity of a series has a significant bearing on its behaviour and properties. For example, persistence of shocks will be definite for non-stationary series and any regression model estimated based on such series will yield spurious results. It therefore very important to test the data generating process of the price series before undertaking any analysis on the data. The presence of unit root in the price data must be probed and if found, the necessary steps must be taken to turn the series into a stationary process. The unit root test was conducted using the Augmented Dickey Fuller procedure and the results thereof are presented in Table 5.1.

Table 5.1: The Augmented Dickey Fuller Unit root tests

Series	**ADF statistic**	**Critical value (95%)**	**Prob.**	**ADF statistics**	**Critical value (95%)**	**Prob.**
	Levels			First Difference		
Producer Price	-2.637	-2.892	0.089	-8.941	-2.893	0.00
W/Sale Price	-2.503	-2.903	0.119	-7.908	-2.893	0.00
Retail Price	-2.544	-2.893	0.109	-15.012	-2.893	0.00

The ADF tests were carried-out for all the data series at a significance level of 95%. The test results presented in Table 5.1 reveal that producer, wholesale and retail prices are non-stationary at levels. This is because the ADF statistics values associated with these series are less than the respective critical values, and the probability (i.e. Prob.) is insignificant at 5%. On the other hand, all series are stationary at first difference as their ADF statistics are greater than the critical value and they all have a significant probability value of less than 5%.

Therefore, the outcomes presented in Table 5.1 fails to reject the null hypothesis of unit root at level. However the tests successfully reject null hypothesis at first difference meaning that the data series are stationery at first difference or integrated of order one, I(1).

5.2.2 Co-integration testing

When the time series are found to be integrated of any order, the next logical step is to perform cointegration tests to determine the existence long-run equilibrium relationship. Since the ADF test in Table 5.1 reveals that the data series are integrated of order one, the Johansen cointegration test was used to test for existence of long-run relationship between producer, wholesale and retail prices. The results thereof are presented in Table 5.2 below.

Table 5.2: Johansen Co-integration Testing Results

Hypothesized No. of CE (s)	**Eigenvalue**	**Trace Statistic**	**0.05 critical value**	**Prob.****
Producer and wholesale price				
None*	0.107	10.517	12.321	0.098
At most 1	0.002	0.019	4.130	0.910
Producer and retail price				
None*	0.112	11.072	12.321	0.080
At most 1	0.003	0.304	4.130	0.887
Wholesale and retail price				
None*	0.130	13.013	12.321	0.038
At most 1	0.001	0.061	4.130	0.839
* denotes rejection of the hypothesis at the 5% significance level ** Mackinnon-Haug_Michelis (1999) p-values.				

Table 5.2 presents the results for Johansen cointegration test. The test was performed focusing on the relationship between three price pairs, namely producer and retail price; producer and retail price; and lastly wholesale and retail price. The results suggest the rejection of hypothesis of no co-integration relationship between the three price pairs under analysis. This implies that there is cointegration relationship between

producer, wholesale and retail prices. Engle and Granger (1987) suggest that if two variables Y and X are cointegrated, the relationship between the two can be expressed as Error Correction Model (ECM). Based on the results presented in Table 5.2 above and taking into account the Granger Representation Theorem, there are therefore reasonable grounds to express the relationship between prices of potatoes at different stages of potato value chain in the form of Error Correction Model.

5.3 Granger causality test

Granger causality test is a statistical hypothesis test method, proposed in Granger (1969), to determine whether one time series variable is useful in predicting the value another variable. According the this test, variable X is said to Granger-cause variable Y if X helps in the prediction of Y. The Granger causality test was used in this study to determine price determination points within the South Africa potato supply chain. The results were also used in identification of dependent variable(s) for the model(s). Because Granger Causality test is very sensitive to the number of lags included in the regression (Foresti, 2006), the unrestricted Vector Autoregressive model (VAR) was performed on variables under analysis using different lag lengths. The lag-lengths that yield the lowest Akaike Information Criterion (AIC) and Schwarz Criterion (SIC) values have been chosen for use in Granger causality test. The results of lad-length selection criterion and Granger causality test are presented in Table 5.3 Table 5.4, respectively.

Table 5.3: Lag-order selection

	Lag	**1**	**2**	**3**	**4**
Price pairs**	**Criteria**				
PP/WP	AIC	28.974	28.929*	28.954	28.961
	SIC	29.135*	29.199	29.335	29.455
PP/RP	AIC	29.919	29.812*	29.842	29.906
	SIC	30.082	30.080*	30.223	30.399
WP/RP	AIC	29.562	29.436*	29.449	29.499
	SIC	29.723	29.707*	29.832	29.992

* denotes the selected lag-length for the specific price pair.

** PP = producer price; WP = wholesale price; and RP = retail price.

As shown in Table 5.3, the AIC and SIC give consistent results with regard to WP/RP and PP/RP price pairings where they both point to selection of 2 lags for both price set. However, conflicting results were obtained for PP/WP price set where AIC suggests selection of 2 lags for this price pairing while AIC results point to 1 lag. The lag length for PP/WP refers to the amount of time it will take before fresh produce markets to respond to price shocks at farm level and vice-versa.

The time lag between producer price and wholesale price is expected to be shorter than the two months suggested by the AIC. This is because potato prices at farm and wholesale levels are expected to be very closely related due the existence of commission-based pricing structure in fresh produce markets where the amount of money paid for potatoes on the market floor is shared proportionately between the producer, agent and management (Chikazunga *et al.*, 2008). The fact that the agents are required, in terms of Agricultural Produce Agents Act regulations, to provide weekly sales reports to producers means that price information is transmitted between producers and agents on a weekly basis. Therefore, the recommended lag length for PP/WP is 1 as suggested by the corresponding SIC value.

In summary, two lags were selected for PP/RP and WP/RP price sets while one lag was selected for PP/WP pairing. The selected lags were utilized in conducting the Granger causality test and the results of such test are presented in Table 5.4.

Table 5.4: Granger Causality Test

Hypotheses	**# Lags**	**F-Statistic**	**Prob.**	**Decision**
∆PP does not granger-cause ∆RP	2	19.96	0.000	Reject
∆RP does not granger-cause ∆PP		1.02	0.333	Accept
∆WP does not granger-cause ∆RP	2	46.05	0.000	Reject
∆RP does not granger-cause ∆WP		2.48	0.090	Accept
∆PP does not granger-cause ∆WP	1	2.43	0.122	Accept
∆WP does not granger-cause ∆PP		15.74	0.0001	Reject

The results in Table 5.4 confirms the occurrence of instantaneous causality between price series in the three categories under analysis. It appears that the wholesale node of potato value chain, commonly known as fresh produce markets, plays a huge role in determination of potato prices in South Africa. The Granger causality test results suggest the rejection of hypotheses that wholesale prices for potatoes do not Granger-cause retail prices and producer prices of the same product. This implies that wholesale prices have an influence on both retail and producer prices for potatoes and this influence is unidirectional without any feedback. The results also shows that producer prices for potatoes have causal effect on retail prices.

The direction of causality between producer prices and wholesale prices is not in line with the general economic theory where input price is expected to have a bearing on output price. Generally, it would be expected that the producer price for potatoes represents the price at which wholesalers purchased potatoes as inputs for their wholesale business. Given this notion, one would then expect the wholesaler to add mark-up and sell potatoes to retailers, in which case the direction of causality would be expected flow downstream, from producer-to-wholesale and then finally from wholesale-to-retail level. However, as noted by NAMC and Commark Trust (2006), this situation may not be applicable to the South Africa fresh produce industry where the National Fresh Produce Markets are an integral part of price-making mechanism. The commission based marketing system is a public and transparent price setting mechanism where demand and supply forces determine a fair reference price on the market floor. This phenomenon is expected to be even more prevalent in potato sub-sector where over 59% of total potato production volumes is sold through National Fresh Produce markets (NAMC and Commark Trust, 2006; and Du Preez, 2011). Based on the issues raised above, it is not surprising that potato prices at fresh produce market Granger causes producer prices and not the other way round. A schematic illustration of Granger causality test is provided in Figure 5.1.

Figure 5.1: Direction of Price causality in the South African potato value chain

NB: the arrow indicates the direction of causality

Figure 5.1 confirms the earlier observation that the potato value chain in South Africa has two price trigger points, namely farm level and wholesale level. The wholesale price influences both the producer and retail price. The farm gate price also has a causal effect on retail prices. The information generated from Granger causality test was useful in determining the dependent and explanatory variables of the model.

5.4 Estimation of long-run relation regression

The Ordinary Least Squares Estimates (OLS) of the co-integrating relationship regressions are presented in Table 5.5. The results are split into three estimated OLS equations, with the first and second equations are focusing on the extent to which retail prices for potatoes are influenced by producer prices (OLS 1), and wholesale prices (OLS 2), respectively. Because the results of Granger causality test in Table 5.4 shows that producer prices are dependent on wholesale prices, the third OLS equation explains the degree to which the wholesale price has a bearing on producer prices for potatoes (OLS 3).

Table 5.5: Long-run equilibrium relationship estimation.

Variable	Coefficient	St. Error	T-statistic	Prob.	R2/DW stat.
OLS 1: Dependent variable: RP					R^2 = 0.52
Intercept	6 210	404.81	15.341	0.000	DW stat =
PP	1.203	0.12	10.149	0.000	0.43
OLS2: Dependent variable: RP					R^2 = 0.54
Intercept	6 256	384.52	16.27	0.000	DW stat =
WP	1.207	0.11	10.581	0.000	0.47
OLS 3: Dependent variable: PP					R^2 = 0.82
Intercept	389.27	141.67	2.75	0.007	DW stat =
WP	0.89	0.042	21.30	0.000	0.55

In the first instance, the regression equations estimated in Table 5.5 appeared to be spurious as their values of R^2 came out greater than the Durbin Watson statistics. However, the unit root tests performed on residuals of the three OLS equations reveal that the residuals are stationery in all cases as reflected in Table 5.6. This serves as confirmation that the estimated equations (OLS1, OLS2 and OLS3) are reputable enough to explain the long-run relationship between retail, wholesale and producer price for potatoes in South Africa. It is further found that the wholesale price for potatoes in South Africa is a significant variable to explain changes in producer and retail prices in the long-run. In addition, the results in Table 5.5 also reveal that producer prices also have an impact on retail prices in the long-run. These findings reaffirm the results of Johnsen's cointegration test in section 5.2.2 that there is indeed cointegration relationship between producer, retail and wholesale prices for potatoes in South Africa. This therefore implies that the relationship between the price series under consideration can be better expressed in the form of Error Correction Model as suggested in Granger representation theorem.

Table 5.6: Unit root test on residuals of OLS equations

Equation	**ADF test statistic**	**Critical value at 5%**	**Prob.**
OLS1	-3.37	-2.89	0.015
OLS2	-3.53	-2.89	0.009
OLS3	-3.88	-2.89	0.003

5.5 Estimation of price asymmetry in the South African potato markets

Based on the existence of long-run cointegration relationship as discovered in Table 5.6 and taking into account the findings of Ganger causality test, the error correction model was estimated to explain the relationship between producer, wholesale and retail prices for potatoes. The findings that are presented in Table 5.7 are subdivided on three categories, namely farm to retail price transmission, wholesale to retail price transmission and wholesale to farm price transmission.

Table 5.7: Error Correction Model Estimates

Farm to retail price transmission		**Wholesale to retail price transmission**		**Wholesale to farm price transmission**	
Dependent variable: ∆RP		Dependent variable: ∆RP		Dependent variable: ∆PP	
Variables	Coefficient	Variables	Coefficient	Variables	Coefficient
Intercept	5.20 (0.88)	Intercept	8.44 (0.800)	Intercept	3.20 (0.90)

Farm to retail price transmission		**Wholesale to retail price transmission**		**Wholesale to farm price transmission**	
Dependent variable: ΔRP		Dependent variable: ΔRP		Dependent variable: ΔPP	
Variables	Coefficient	Variables	Coefficient	Variables	Coefficient
ΔPP	0.28 (0.0004)	ΔWP	0.12 (0.120)	ΔWP	0.81 (0.00)
ΔPP_{t-1}	0.40 (0.00)	ΔWP_{t-1}	0.54 (0.000)	ΔWP_{t-1}	0.27 (0.02)
ΔRP_{t-1}	0.18 (0.032)	ΔRP_{t-1}	0.16 (0.030)	ΔPP_{t-1}	0.17 (0.11)
ΔRP_{t-2}	0.23 (0.005)	ΔRP_{t-2}	0.21 (0.004)	ΔPP_{t-2}	-0.01 (0.81)
ECT^{+}	-0.310 (0.009)	ECT^{+}	-0.320 (0.0001)	ECT^{+}	-0.055 (0.58)
ECT^{-}	-0.280 (0.001)	ECT^{-}	-0.490 (0.000)	ECT^{-}	-1.084 (0.00)

Figures in brackets represent probability values

The results in Table 5.7 shows that potato prices are transmitted asymmetrically in all the three scenarios under analysis. Looking at farm to retail price transmission, the coefficient for positive Error Correction Term (ECT^{+}) is significant and higher than the coefficient for the negative Error Correction Term (ECT^{-}) which is an indication that retail prices for potatoes are more responsive to positive shocks in producer prices than they are to negative shocks. The price the retail price adjusts by 31% per month towards equilibrium when price shocks at producer level are positive and by 28% when price shocks at producer level are negative. This result is consistent with findings of Kinnucan and Forker (1987) and Bor *et al.* (2014). The former finds price asymmetry in the USA milk markets and further reveals that producer price increases for milk are passed to the retail more fully and rapidly than farm price decreases. Bor *et al.* (2014)

also found that retail milk prices in Turkey tend to adjust more quickly to input price increases than they do to input price decreases. Results from other studies suggest that retailers may reduce their prices more slowly compared to reduction in producer prices to avoid running out of stock (Reagan and Weitzman, 1982; Balke *et al.*, 1998; Meyer and von Cramon-Taubadel, 2002 and Uchezuba 2010). On the other hand, Ward (1982) and Heien (1980) propose other factors such as perishability and menu cost can also lead to asymmetric price transmission.

On other hand, the results relating to wholesale-to-retail transmission shows that the declines in wholesale prices are transmitted more fully and rapidly to retail level than the wholesale price increases. Table 5.7 shows that the retail adjust by 49% per month towards equilibrium in response to negative shocks in wholesale prices and that the rate at which retail prices adjust to equilibrium in response to positive wholesale shocks is 35% at a time. This signifies the existence of negative asymmetry between wholesale and retail prices. The negative price asymmetry is not surprising for perishable commodities like potatoes that are characterised by shorter shelf life. As noted by Ward (1982), retailers of perishable products might hesitate to raise prices as upstream prices increase for fear of losses that might result from spoilage and reduced sales. Another important point to consider is the fact that the wholesalers, who typically sells at prices lower than retailers, sometimes competes with retailers for the same customer, which might make it very difficult for retailers to respond to each upward price adjustment at wholesale level because the retailer’s price is already relatively higher due to retailer’s margins.

With regard to wholesale-to-farm price transmission, the negative Error Correction Term is statistically significant while the positive Error Correction Term is not significant. This implies that producer prices for potatoes are not responsive to positive price shocks at wholesale level in the short run and responsive to negative price shocks at wholesale level. This implies that the marketing intermediaries are quick in transferring wholesale price reductions to the producer in order to stretch their own margins and reluctant transfer wholesale price increases to the producer. This seem to confirm the findings by von Cramon-Taubadel (1998) where it is found that wholesale prices react more rapidly when the margin is squeezed than when it is stretched. Cutts and Kirsten (2006) suggest that the food value chains are generally less concentrated at the farm level compared to down-stream, implying that the down-stream intermediaries, who are mostly structured in an oligopolistic manner, might be better positioned than producers to respond opportunistically to variety of price shocks. The findings in Table 5.7 seem to confirm this argument in a sense that the marketing intermediaries such as wholesalers and retailers seem to have some lever to increase their own margins in as far as they are involved with producers. For example, in the case of producer to retail price transmission the retail prices are more responsive to positive producer price shocks and less responsive to reductions in producer price, which is the action that stretches the margins on the part of the retailer. On the other hand the wholesale price increases are not fully transferred to the producer price while the reduction in wholesale price is transferred to the producer rapidly and fully. This also appears to be a wholesale-margin-stretching and a farmers-share-squeezing phenomenon.

CHAPTER 6: SUMMARY, CONCLUSSION AND RECOMMENDATIONS

This section provides summary of the study focusing on key issues emanating from each chapter. It also outlines concluding remarks, policy recommendations and finally proposes several areas for future research.

6.1 Summary

The aim of the study was to determine the nature of price transmission between different levels of potato value chain in South Africa. The study was undertaken under the auspices of three objectives, which are to investigate the nature of long-run relationship between producer, wholesale and retail prices for potatoes; to determine characteristics of the long-run relationship; and to determine the direction of price causality along the South African potato value chain.

The study reviewed the previous literature in the area of price transmission and noted that price asymmetry is a rule rather than an exception. Most studies reviewed found the existence of price asymmetry between the price series examined in those studies. It was also noted that potato is the most important vegetable crop in South Africa due to the contribution by potato sector to the gross value of agricultural production, to export earnings and to food security in the country and throughout the SACU region.

The study used the Augmented Dickey Fuller test and Johansen cointegration test to examine time series properties of the data. The data series used in this study were found to be non-stationary at level and stationary at first difference. The results of Johansen's cointegration test found the existence of long run equilibrium relationship between all price pairs under analysis, which paved a way for the use of Error

Correction Model to examine the nature of price transmission within potato value chain.

The Granger Causality test revealed that the wholesale market is very influential in determination of potato prices in South Africa. The results shows that wholesale prices have an influence on retail and producer prices for potatoes in South Africa. The Granger Causality test also reveal that producer prices also have an influence on retail prices but not on wholesale prices.

The results of Error Correction Model suggest the existence of price asymmetry in South African potato market. The results revealed that retail prices for potatoes are more responsive to positive shocks in producer prices than they are to negative shocks, implying that retailer are more responsive to price shocks that squeeze their margins and less responsive to shocks that stretches them. The negative price asymmetry was found between wholesale and producer prices in that producers are more responsive to negative price shocks at wholesale level than they are to positive shocks.

6.2 Conclusion

The findings of the study seem to suggest that retailer and wholesalers are quick to respond to price changes that threatens their margins and delays their response when the shocks stretch their margins, particularly in as far as their relations with farmers are concerned. Given this phenomenon, one might be tempted to assume that retailers and wholesalers have more market power over producers and are therefore able to alter their response to producer price shocks depending on whether the shocks are positive or negative. Previous research suggest that this type of asymmetry can lead to welfare losses on the part of consumers because increases in farm gate prices are transferred quickly to them while decreases in producer prices are not transmitted fully and quickly to the consumer market. The question therefore is whether the observed price asymmetry be attributed to lack of competition or the presence market power among retailers and wholesalers?

According to the literature, it is not always a good idea to single out the market power as sole source of price asymmetry. There are other factors that can also lead to price asymmetry such as perishability, government intervention, menu adjustment cost as well as search cost. The current study was aimed as determining the existence of price asymmetry and therefore did not go to the extent of identifying the underlying causes of price asymmetry.

6.3 Limitations of the study

The study focuses on vertical price transmission in the South African potato markets with focus on how prices are passed-through between farms, wholesale markets and retail outlets. The major limitation of this study is that the study used prices for potatoes sold in Johannesburg Market as a proxy for wholesale prices for the entire country due to lack of reliable data on average wholesale prices for the entire Country. The study also focuses on price transmission mechanism, which provides very insightful information about how prices at different levels of potato value chain interrelate with one another. However, the findings could have provided more information on the conduct of value chain players if reliable data on transaction costs was available as this would have made it possible to account for the delays and break-ups in the pass-through of prices.

6.3 Recommendations

It is also recommended that the government continues and strengthens its efforts to monitor food prices throughout the republic in order to be able to make well informed food security policies and provide more regular food price data to stakeholders. The government must consider broadening food price monitoring system to report food prices per region and province as this will make it possible to evaluate price transmission in economically marginalised communities. In addition, efforts must be made to collect data on marketing or transaction costs as this will make it possible to incorporate transaction costs in the price transmission analysis, thereby making it possible to account for some of the contributing factors to price asymmetry. The government and the agricultural sector must consider initiating an inquest into structure, conduct and performance of the potato industry in South Africa to investigate whether the positive price asymmetry in potato markets is not as a result of collusive or anticompetitive behaviour among influential role-players.

6.4 Suggestions for future research direction

It is necessary that further research be undertaken to investigate causes of price asymmetry in the South African potato markets. It may also be necessary to undertake further research on price transmission focusing on other food commodities and such studies must be benchmarked against the current study to ascertain whether the current findings are peculiar to the potato industry or also applicable to other vegetable commodities.

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APPENDIX A: DATA FOR PRODUCER, WHOLESALE AND RETAIL PRICES FOR POTATOES

Month	R/TON Producer Price	R/TON Wholesale Price	R/TON Retail Price	R/KG Retail Price
Jan-10	2620	2659,46	9780	9,78
Feb-10	2384	2408,52	9160	9,16
Mar-10	2205	2273,82	9080	9,08
Apr-10	2556	2603,22	8910	8,91
May-10	2499	2538,92	9170	9,17
Jun-10	2715	2748,31	8980	8,98
Jul-10	2063	3174,11	9100	9,1
Aug-10	3495	3553,81	9540	9,54
Sep-10	3217	3233,11	9770	9,77
Oct-10	2442	2291,34	9390	9,39
Nov-10	2147	2100,19	8850	8,85
Dec-10	2138	2248,67	8390	8,39
Jan-11	2012	2067,33	8550	8,55
Feb-11	1946	1953,43	8140	8,14
Mar-11	2012	1937,85	8820	8,82
Apr-11	2197	2271,74	8840	8,84
May-11	2574	2528,78	9370	9,37
Jun-11	2635	2634,76	9440	9,44
Jul-11	2439	2505,74	9360	9,36
Aug-11	2761	2819,36	9140	9,14
Sep-11	3150	3225,87	9310	9,31
Oct-11	3513	3587,97	9860	9,86
Nov-11	3028	3085,19	9540	9,54
Dec-11	2801	2876,79	9710	9,71
Jan-12	2304	2316,89	9370	9,37
Feb-12	2609	2697,62	9310	9,31
Mar-12	2256	2249,72	9200	9,2
Apr-12	2482	2494,45	9040	9,04
May-12	2468	2503,44	9060	9,06
Jun-12	2364	2348,41	8940	8,94
Jul-12	2262	2243,1	8820	8,82
Aug-12	2361	2345,25	8260	8,26
Sep-12	2653	2792,67	8360	8,36
Oct-12	3563	3752,92	8810	8,81
Nov-12	3100	3171,97	9620	9,62
Dec-12	3378	3649,36	9600	9,6
Jan-13	3363	3572,51	9830	9,83
Feb-13	2929	2987,41	21410	21,41
Mar-13	2701	2782,37	9640	9,64
Apr-13	2973	2960,2	9610	9,61
May-13	3062	3080,36	9580	9,58

Month	R/TON Producer Price	R/TON Wholesale Price	R/TON Retail Price	R/KG Retail Price
Jun-13	3073	3028,61	9470	9,47
Jul-13	3142	3124,82	9470	9,47
Aug-13	3161	3138,41	9380	9,38
Sep-13	3983	4021,45	9760	9,76
Oct-13	4038	4069,82	9940	9,94
Nov-13	4109	4251,78	9770	9,77
Dec-13	4054	4123,09	9940	9,94
Jan-14	3409	3342,1	10680	10,68
Feb-14	3318	3331	10270	10,27
Mar-14	3351	3425,17	10430	10,43
Apr-14	2811	2805,04	9980	9,98
May-14	3187	3209,06	9910	9,91
Jun-14	3100	3030,53	10220	10,22
Jul-14	3192	3177,91	9550	9,55
Aug-14	3620	3648,97	9710	9,71
Sep-14	4290	4239,76	10250	10,25
Oct-14	4076	4054,83	10480	10,48
Nov-14	3529	3562,23	10400	10,4
Dec-14	3299	3411,68	9990	9,99
Jan-15	2649	2563,86	10330	10,33
Feb-15	2649	2902,95	9990	9,99
Mar-15	4254	3150,96	9960	9,96
Apr-15	4254	2988,57	10190	10,19
May-15	4254	2632,43	9950	9,95
Jun-15	3549	2471,73	9580	9,58
Jul-15	3549	2409,01	9590	9,59
Aug-15	3549	2257,78	9280	9,28
Sep-15	3551	2795,03	9190	9,19
Oct-15	3551	2624,05	9360	9,36
Nov-15	3551	3385,21	9330	9,33
Dec-15	3653	4339,81	9630	9,63
Jan-16	5232	5364,94	11090	11,09
Feb-16	5940	6075,6	12880	12,88
Mar-16	6274	6416,9	14380	14,38
Apr-16	4939	4920,56	16030	16,03
May-16	4374	4384,76	14460	14,46
Jun-16	4461	4450,22	13500	13,5
Jul-16	4224	4194,32	12570	12,57
Aug-16	4090	4050,65	12180	12,18
Sep-16	4248	4212,69	11710	11,71
Oct-16	4760	4785,66	11720	11,72
Nov-16	4359	4388,04	12230	12,23
Dec-16	4283	4383,58	12140	12,14

Month	R/TON Producer Price	R/TON Wholesale Price	R/TON Retail Price	R/KG Retail Price
Jan-17	4513	4522,86	12510	12,51
Feb-17	3720	3794,64	12490	12,49
Mar-17	2934	3794,64	12310	12,31
Apr-17	2658	3794,64	12000	12
May-17	2977	3794,64	11550	11,55
Jun-17	2747	3794,64	11210	11,21
Jul-17	2761	3794,64	10730	10,73
Aug-17	3098	3794,64	10720	10,72
Sep-17	3733	3794,64	11090	11,09
Oct-17	4341	3794,64	11700	11,7
Nov-17	3844	3794,64	11790	11,79
Dec-17	4498	3794,64	11820	11,82