Price transmission in tomato markets of Limpopo Province, South Africa

by

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DECLARATION

I declare that the mini-dissertation hereby submitted to the University of Limpopo for the degree of Master of Science in Agriculture (Agricultural Economics) has not previously been submitted by me for a degree at this or any other university; that it is my own work in design and execution, and that all material contained herein has been duly acknowledged.

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Surname, Initials (title)   **Date**

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DEDICATION

This work is dedicated to my lovely mother Ms. S.N Tsivai. Into my heavenly father's hands I also commit this piece of inspired work.

ABSTRACT

The Limpopo Province is home to South Africa's major tomato producer, who is also the largest producer of the commodity in the Southern Hemisphere. Regardless of its importance in the tomato industry of the country, there are few studies analysing the mechanism through which prices of tomatoes are determined and transmitted from the farm gate in Limpopo to the various provincial, local and international markets. This study attempts to fill the knowledge gap on the performance of Limpopo Province's tomato markets by examining vertical price linkages amongst successive marketing levels. With the aid of both surveys and document analysis, daily tomato prices were collected at three levels that reflect the marketing chain of Limpopo produced tomatoes. Through marketing margin analysis, it was established that the farmers' portion of the consumer's Rand is low. About 85.1% of the consumer's Rand goes to pay for marketing margins. Granger causality tests show that both the wholesale and retail prices are caused by farm gate prices, whereas an independent causal relationship was found between wholesale prices and retail prices. The study also found a long run cointegration relationship between farm gate prices and retail level prices, and not the same for the relationship between farm gate and wholesale prices. Furthermore, it was found that retailers are quick to react to increases in farm gate prices and slow in adjusting to price decreases. On the other hand, wholesale prices were found to be symmetrical to farm gate prices. These results suggest that the transmission of price information is more efficient between the farm and wholesale markets than between the farm and retail markets. Nonetheless, there is scope for increasing efficiency of tomato marketing in the province.

Key words: Price transmission, marketing margins, vertical price linkage, market dominance, tomato markets, Limpopo Province

CONTENTS PAGE

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ADF   Augmented Dickey Fuller

AIC   Akaike Information Criterion

AoR   Asymmetry of Response

APOL   Agro-processors of Limpopo

AR   Autoregressive model

ARMA   Autoregressive and Moving Average model

ARIMA   Autoregressive Integrated Moving Average model

CCA   Co-movement and Completeness of Adjustment

CE   Cointegration Equation

DAFF   Department of Agriculture, Forestry and Fisheries

DC   Distribution Center

DFP   First difference of Farm Prices

DlnFP   First differenced natural Logarithm of Farm Price

DlnRP   First differenced natural Logarithm of Retail Price

DlnWP   First differenced natural Logarithm of Wholesale Price

DRP   First difference of Retail Prices

DSA   Dynamics and Speed of Adjustment

DW   Durbin Watson

DWP   First difference of Wholesale Prices

ECM   Error Correction Model

ECT   Error Correction Term

FAO   Food and Agriculture Organization

FBO   Food Business Operation

FDC	Foodhold Distribution Centre
FP	Farm gate Price
FPE	Final Prediction Error
FRGMM	Farm to Retail Gross Marketing Margin
FWGMM	Farm to Wholesale Gross Marketing Margin
GMM_p	Producer's Gross Marketing Margin
HQIC	Hannan-Quinn Information Criterion
JFPM	Johannesburg Fresh Produce Market
*ln*FP	Natural Logarithm of Farm Price
*ln*RP	Natural Logarithm of Retail Price
*ln*WP	Natural Logarithm of Wholesale Price
LTGA	Limpopo Tomato Growers Association
MA	Moving Average model
NAMC	National Agricultural Marketing Council
NFPM	National Fresh Produce Markets
OLS	Ordinary Least Squares
PP	Philips Perron test
RM	Retailer's Margin
RP	Retail Price
SIC	Schwarz Information Criterion
TGMM	Total Gross Marketing Margin
VAR	Vector Auto Regressive model
VLOSC	VAR Lag Order Selection Criteria
WM	Wholesaler's Margin

WP   Wholesale Price

WRGMM   Wholesale to Retail Gross Marketing Margin

CHAPTER 1: INTRODUCTION

1.1 Background

Agricultural productivity has improved throughout history because of economic progression, innovation, specialisation, research and development (Fuglie *et al.,* 2007; Fuglie and Nin-Pratt, 2012; Nin-Pratt, 2013). This has increased the productive capacities of farmers who in time have been able to produce in excess of what is needed for home consumption and subsistence. Such developments augmented the significance and complexity of marketing and have seen the establishment of arenas to facilitate the exchange of marketable surplus between producers and consumers.

In the context of the tomato industry of South Africa, it is highlighted in Department of Agriculture, Forestry and Fisheries (DAFF) (2011) that production of tomato occurs in all the nine provinces of South Africa by both commercial and emerging farmers. However, different provinces produce varied volumes due to environmental disparities amongst other factors. The Limpopo Province with its warmer climate plays the most vital role in the country's tomato production. According to DAFF (2011) the province contributes about 3 590 ha to the country's total area planted to tomatoes. Limpopo Tourism and Parks Board (2011), suggests that almost 60% of the country's tomatoes are produced in Limpopo Province which is responsible for about 45% of the Johannesburg Fresh Produce Market's annual turnover. However, the Limpopo Province's tomato producing industry's concentration is high which in economics sense means that a large share of total production is dominated by a few large producers. Limpopo Tourism and Parks Board (2011), indicates that only one farming company (ZZ2) is responsible for about 40% of the province's 60% contribution to South Africa's total tomato production.

Even though the majority of tomato is produced in the Limpopo Province, the commodity is consumed in all parts of the country and is also exported thus; there is some degree of spatial separation between production and consumption. Such spatial distribution calls for the need for an efficient and effective marketing system to facilitate the movement of tomatoes from the point of production to the end user. Bringing the agricultural product from the agricultural enterprise to the consumer according to Saccomandi (1998), involves a series of functions and productive activities that interconnect. The process also depends on the current state of

1

technology, the organization of productive activities and the spatial distribution of production and consumption.

1.2 Problem statement

There is high industry concentration in the tomato producing industry of the Limpopo Province. Such a situation where the industry is dominated by a few large firms paves way to major producers potentially using their market power to influence pricing strategies from time to time. As to which of the participants in the chain will consequently suffer or benefit from impending price shocks depends on the degree to which market players adjust to price signals. It also depends on the timing in response and the extent to which their adjustment to price shocks is asymmetric as shown in Vavra and Goodwin (2005).

Particular aspects of participants' response to price movements may also have important implications for marketing margins of several players in the marketing chain of tomato in Limpopo Province. While farmers may view their proportion of the consumer's Rand as low, tomato consumers on the other hand experience continual rising prices of this commodity. This as a result raises the question of whether intermediaries are passing more rapidly any cost increase while transmitting slowly and less completely cost savings.

Considering that several studies on price transmission in fresh agricultural produce markets have been conducted in South Africa, (e.g., Mashamaite and Moholwa, 2005; Jooste *et al.,* 2006; Kirsten and Cutts, 2006; Funke, 2006), it is evident that the subject is of a considerable economic interest. However, there is a gap in literature on price transmission in tomato markets of Limpopo despite the province's importance in the South African tomato industry. No up to date empirical evidence has been provided to explain vertical price linkages between farm, wholesale and retail levels for Limpopo produced tomatoes. Furthermore, it is uncertain at what stage tomato prices are being determined along the marketing chain. This lack of information makes it difficult to develop effective policies to improve the performance of tomato marketing in the province. The question of how the province's tomato marketing efficiency can be enhanced therefore remains unanswered given that very little awareness exists on the market's current economic performance.

1.3 Motivation for the study

Tomato is one of the most important agricultural products of Limpopo Province. Undertaking a study that concerns tomato is thus essential considering that any consequential improvement in the commodity's marketing will directly or indirectly have a positive economic impact to the province as a whole. Although similar studies on price transmission have been conducted elsewhere in South Africa, most of these studies were not focused on tomato marketing, and their findings and recommendations may be insufficient to address the challenges prevalent in tomato markets of Limpopo Province. Undertaking a study of this nature on specific tomato markets for the Limpopo Province will assist in identifying problems peculiar to the study area. Recommendations will be given to steer appropriate policy interventions that can effectively enhance the performance of tomato marketing in Limpopo Province.

1.4 Purpose of the study

1.4.1 Aim

This study seeks to establish and analyse the nature of price transmission in tomato markets of Limpopo Province, South Africa. Such analysis will help in determining the performance of tomato markets in the province.

1.4.2 Objectives

The objectives of the study are to:

  i.   give an overview of tomato production and marketing in Limpopo Province.

 ii.   estimate the point(s) of price determination and direction of causality along the marketing chain for tomato in Limpopo Province.

iii.   ascertain whether or not changes in prices at the point(s) of determination are transmitted symmetrically to other stages in the marketing chain for tomato in Limpopo Province.

1.5 Hypotheses

  i.   Price and direction of causality along the marketing chain for tomato in Limpopo Province are determined beyond the farm gate.

ii.   Changes in prices at the point of determination are transmitted symmetrically to other stages in the marketing chain for tomato in Limpopo Province.

1.6 Research questions

i.   At which level(s) along the tomato marketing chain is price determined in Limpopo Province and what is the direction of causality?

ii.   Are price changes at the point of determination transmitted symmetrically to other stages in the marketing chain for tomato in Limpopo Province?

1.7   Structure of the report

The rest of this report is structured into five remaining chapters. Chapter 2 on literature review discusses concepts, approaches and techniques used in agricultural price analysis. The chapter also reviews how other authors have tackled the subject of price transmission in South Africa, the rest of Africa and elsewhere in the world. Chapter 3 provides an overview of the tomato industry in South Africa. Chapter 4 explains the methodology applied to this study. Chapter 5 covers the quantitative analyses performed, as well as key findings of this study. Chapter 6 provides conclusions and possible recommendations to policy makers.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on several concepts, approaches and techniques used in agricultural price analysis. A comprehensive explanation of terminologies and approaches to time series is given followed by a review of previous studies of price transmission in South Africa, the rest of Africa and elsewhere in the world.

2.2 Explanation of concepts

2.2.1 Marketing Margin Analysis

According to Food and Agriculture Organisation (FAO) (2002), the percentage share of the final price, which is taken up by the marketing functions, is what is known as the marketing margin. Guvheya *et al.* (1998) treated the concept of marketing margins as differences between prices at different levels in the marketing channel which capture the proportion of the final selling price that a particular agent in the marketing chain adds. Elitzak (1996) characterizes marketing margins or the farm-to-retail price spread as the difference between the farm value and retail price that represents payments for all assembling, processing, transporting and retailing charges added to farm products. Sreenivasa *et al.* (2007) defined total intermediaries' marketing margin in terms of its constituting elements. These include profits and returns, which accrue to them for storage, the interest on capital and establishment after adjusting the marketing losses due to handling.

Cox (2009) noted that producers often wonder about the large difference between the prices that consumers pay for food and the prices that farmers receive. However, high marketing margins can be justified by costs involved in distributing the product from point of production to the final consumer. It can be argued though, that too high a percentage reflects some exploitation of either farmers or consumers. Wohlgenant (2001) investigated marketing margins and identified some of the questions that are frequently asked about the issue. These questions, which have attracted considerable interest across literature and amongst researchers and policy makers, include; Are marketing margins too large? Why are margins different among products? How have margins changed over time? Are margins scale-dependent, that is, do they vary systematically with the quantity handled or marketed? Are margins determined via mark-up pricing? What is the incidence of marketing costs on retail

prices and farm prices? How quickly are farm prices transmitted to the retail level and how quickly are retail price changes transmitted to farmers? What is the relationship between concentration and market power? Is increased concentration detrimental or beneficial to producers?

In order to have a thorough and exact investigation, Mojtaba *et al.* (2010) recommended that the marketing margin be divided into two smaller portions namely Retailer Margin (RM) and Wholesaler Margin (WM). RM refers to the difference between the price paid by consumers and the price that retailers pay to the wholesalers. WM refers to the difference between the price at which wholesalers sell their product and the price that they pay to the farmers.

2.2.2 Price determination

According to Schnepf (2006) price represents the equilibrium point where demand and supply meet in the market place. Schnepf (2006) also emphasizes that the general price level of an agricultural commodity, at any stage, is influenced by a variety of market forces that can alter the current or expected balance between supply and demand. According to Holland (1998) price determination for many consumer products is in most cases a function of the cost of production and a desired level of mark-up. Price determination by this desired level of mark-up is what is referred to as cost-plus pricing, mark-up pricing or full-cost pricing which in Salvatore (1993) is related to three rules of thumb. The first is termed; mark-up percent, which is the proportion of profit to total cost. The second is the gross margin percent, which is the proportion of profit to the selling price, and lastly, profit margin, which is the difference in selling price and total cost.

2.2.3 Price transmission

Once the price is determined at one level along the marketing chain, it has to be transmitted to other levels. Price transmission is a broad concept that can be referred to in different ways. According to Colman (1995), price transmission is the extent to which a price series at one location causes changes in, or correlates with price changes at another location. Rapsomanikis *et al.* (2003) explained the concept based on three components, which are co-movement and completeness of adjustment (CCA), dynamics and speed of adjustment (DSA) and asymmetry of response (AoR). CCA entails full transmission of changes in prices in one market to the other at all points of time. DSA covers the process by and rate at which changes

in one market filter to the other market/ levels. The final component AoR entails whether upward and downward movements in the price at one level are either symmetrically or asymmetrically transmitted to the other levels.

Similarly, Vavra and Goodwin (2005) gave four aspects as a basis for assessing asymmetric price transmission. The first is the aspect of magnitude which is concerned with how big the response is at each level as a result of a shock of a given size at another level. The aspect of speed measures how fast or slow the adjustment process is and also considers whether there are significant lags in adjustment. The nature of price transmission considers whether any adjustment that follows positive and negative shocks at a particular marketing level displays asymmetry. The fourth aspect which is direction ascertains the extent to which adjustments contrast, depending on whether a shock is transmitted upwards or downwards the supply chain.

Putting the aforementioned aspects into consideration, four types of asymmetry can therefore be analysed which include positive and negative asymmetry, asymmetry in magnitude, asymmetry in speed and asymmetry in both speed and magnitude. The definition of each is based on the diagrams in Annex 1. Asymmetry in magnitude measures whether there is a more/less than proportionate change in downstream prices in response to a price shock upstream. Asymmetry in speed measures whether downstream prices take some time to react to a shock in upstream prices and the extent of delay/instantaneousness in response. Positive asymmetry occurs when prices downstream react more fully or rapidly to an increase in prices upstream than to decreases. Negative asymmetry occurs when prices downstream react more fully or rapidly to a decrease in prices upstream than to increases (Karantininis *et al.*, 2011; Meyer and von Cramon-Taubadel, 2000).

2.3 Time series analysis

While researchers may use cross sectional data in some studies, numerous economic studies require a collection of time series data. However, time series data are more difficult to analyse than data of a cross sectional nature due to the dependency that exists amongst economic observations over time. The following section explores the techniques employed in time series analysis.

2.3.1 Time series data

The definition of time series according to Vavra and Goodwin (2005) is a sequence of data points, measured typically at successive times, spaced apart at uniform intervals. According to Asteriou and Hall, (2007), a time series data set consists of observations on one or several variables over time that are arranged in chronological order and can have different time frequencies such as biannual, annual quarterly, monthly, weekly, daily and hourly. Usually time series data are represented with the subscript *t* for example, if Y represents the retail price of tomatoes from January to December 2011 then we can represent it as: Y_t for *t*=1, 2,3…..,T where t =1 for January 2011 and *t* = T for December 2011. Asteriou and Hall, (2007), consider time to be a very important dimension in time series data sets since past events are capable of influencing future events and lags in behaviour are customary in social sciences. If say, the retail prices of tomatoes are lagged by one, two up to *n* periods, that is, they respond to a certain phenomenon after a month, two or so on, we can represent this by Y_{t-1}, Y_{t-2},….,Y_{t-n} .However, if say the retail price is leading *k* period, then it will be presented as Y_{t+k}.

2.3.2 Stationarity

Lemay (1999) provides a convenient definition of stationarity as the extent to which there is no systematic change in either mean or variance in time series. Vavra and Goodwin (2005) noted that most economic time series are non-stationary, and they need some transformation through differencing or detrending to make them stationary, otherwise the regression will be spurious. Spurious regressions occur when the mean, variance and covariance of a time series vary with time. In the case of analysis with a non-stationary series, the classic results of a usual regression cannot be legitimate.

Asteriou and Hall (2007) illustrated the characteristics under which a time series is covariance stationary. Firstly, a time series has to exhibit mean reversion in that it fluctuates around a constant long run mean. Secondly, series should have a finite variance that is invariant with time and thirdly, the time series should have a theoretical correlogram that diminishes as the lag length increases. Simplifying the above conditions, a time series Y_t is said to be stationary if and only if its mean, its variance and its covariances remain constant over time that is;

(a) E (Y_t) = constant for all *t ;*

(b) *Var* (Y_t) = constant for all *t* ; and

(c) Cov (Y_t, Y_{t+k}) = constant for all *t* and all $k \neq 0$.

Koop (2000) considers unit root nonstationarity as the most prevalent in many macroeconomic time series and the author provides the criteria for determining whether a time series variable say Y_t is stationary or has a unit root. Koop's (2000) criteria uses a time series representation called an Autoregressive model of order one, i.e. AR (1). The AR (1) model includes one lagged value of the dependent variable among its explanatory variables such that given a relationship $Y_t = \sigma Y_{t-1} + u_t$ the criteria for testing whether Y_t is stationary is as follows;

(a) In the AR (1) model, if σ = 1, then Y_t has a unit root. If however, |σ|<1 then Y_t is stationary.

(b) If Y_t has a unit root then its auto correlations will be near one and will not drop much as lag length increases.

(c) If Y_t has a unit root, then it will have a long memory. Stationary time series do not have long memory,

(d) If Y_t has a unit root then the series will exhibit a trend behaviour especially if the intercept is non-zero

(d) If Y_t has a unit root, then ΔY_t will be stationary. That is the reason why all series that have unit roots are often referred to as difference stationary series.

2.3.3 Unit root

According to Vavra and Goodwin (2005) any variable that is non-stationary is said to contain a unit root. Gujarati and Porter (2009) demonstrate the concept of unit root stochastic processes where given a relationship;

$$Y_t = \sigma Y_{t-1} + u_t \qquad\qquad -1 \leq \sigma \leq 1 \qquad\qquad \text{(equation 2.1)}$$

If σ = 1 a unit root problem is faced implying that Y_t is non-stationary but if however |σ| < 1 then Y_t is definitely unit root stationary. The use of data with unit roots is strongly discouraged since it may lead to severe inaccuracy when executing statistical inferences.

2.3.4 The random walk phenomenon

According to Gujarati and Porter (2009), a random walk phenomenon exists when the best prediction of the price of a stock tomorrow is equal to its price today plus a purely random shock. The classical example of non-stationary time series is the random walk model which can be distinguished as follows;

(a) Random walk without drift (no intercept)

This is a form of AR(1) model where the first difference operator of variable Y_t is equal to the white noise error term u_t with mean 0 and variance σ^2. At any given time t the series Y_t is said to be a random walk if;

$$Y_t = Y_{t-1} + u_t \qquad\qquad \text{(equation 2.2)}$$

Such that if the process is started at some time 0 where $Y_t = Y_0$,

$$Y_t = Y_0 + \Sigma\, u_t \qquad\qquad \text{(equation 2.3)}$$

Where, $\Sigma\, u_t$ is a stochastic trend

(b) Random walk with drift/ intercept term.

This is a form of AR(1) model where the first difference operator of variable Y_t is equal to the white noise error term u_t with mean 0 and variance σ^2 plus a drift parameter (δ) as shown below;

$$Y_t = \delta + Y_{t-1} + u_t \qquad\qquad \text{(equation 2.4)}$$

In equation 2.4 above, Y_t drifts upwards or downwards depending on whether δ positive or negative. As in random walk without drift, in the random walk with drift case, the mean and the variance both increase with time thus implying that the two equations depict non-stationary stochastic processes.

(c) Random walk with drift and deterministic trend

This is a non-stationary process that combines a random walk with an intercept term or drift parameter (δ) and a deterministic trend (βt) as shown below;

$$Y_t = \delta + Y_{t-1} + \beta t + u_t \qquad\qquad \text{(equation 2.5)}$$

In equation 2.5 above, Y_t is specified by the last period's value, a drift, a trend and a stochastic component. If $\delta\neq0$ and $\beta\neq0$ then differenced series $\Delta Y_t = \delta + \beta t + u_t$ which is still time varying. Therefore the mean of differenced series is non-stationary and it requires detrending on the differenced series to make it stationary.

2.3.5 Testing for unit root stationarity

There are a number of ways for testing for stationarity of time series data but only two that are popularly used are reviewed. These common methods for testing unit root are; the Dickey Fuller test and the Phillips Perron test.

(a) The Dickey Fuller (DF) test

The DF test is a procedure for formally testing for unit root as devised in Dickey and Fuller (1979). The Dickey Fuller test is based on the simple AR (1) model of the form;

$$Y_t = \sigma Y_{t-1} + u_t \qquad\qquad -1\leq \sigma \leq 1 \qquad\qquad \text{(equation 2.6)}$$

The goal is to ascertain whether σ is equal to 1 (unit root), so this will be achieved by testing the null hypothesis $H_0 : \sigma = 1$ against the alternative hypothesis H_1: $\sigma < 1$. A more convenient version as termed in Asteriou and Hall (2007), of the test is found by subtracting Y_{t-1} on both the right and left hand sides of the AR (1) model shown in equation 2.6 such that;

$$Y_t - Y_{t-1} = \sigma Y_{t-1} - Y_{t-1} + u_t \qquad\qquad \text{(equation 2.7)}$$

$$\Delta Y_t = (\sigma - 1)\, Y_{t-1} + u_t \qquad\qquad \text{(equation 2.8)}$$

If say $\emptyset = \sigma - 1$, then the first difference operator ΔY_t will be as shown below;

$$\Delta Y_t = (\emptyset)\, Y_{t-1} + u_t \qquad\qquad \text{(equation 2.9)}$$

If ever $\emptyset = 0$ then $\Delta Y_t = u_t$ which is a white noise error term that has a mean = 0 and a constant variance, implying that the first differences of a random walk time series are stationary. The null hypothesis that H_0: $\emptyset = 0$ therefore need to be tested, where the alternative hypothesis is H_1: $\emptyset < 0$. If the null hypothesis is rejected then the time series is stationary.

The DF test is estimated in three different regression equations and thus hypothesis;

Y_t is a random walk: $\hspace{3cm} \Delta Y_t = (\emptyset)\, Y_{t-1} + u_t \hspace{1cm}$ (equation 2.10)

Y_t is a random walk with drift: $\hspace{1.5cm} \Delta Y_t = \delta_1 + (\emptyset)\, Y_{t-1} + u_t \hspace{0.5cm}$ (equation 2.11)

Y_t is a random walk with drift and deterministic trend: $\Delta Y_t = \delta_1 + \delta_2 t + (\emptyset)\, Y_{t-1} + u_t$

$$\text{(equation 2.12)}$$

where, in each case, the null hypothesis is H_0: $\emptyset = 0$ and the alternative hypothesis is H_1: $\emptyset < 0$. If the DF- test statistic is less than the critical value then the null hypothesis of a unit root is rejected to conclude that Y_t is stationary process.

(b) The Phillips- Perron (PP) test

The PP test as worked out in Philips and Perron (1988) use nonparametric statistical methods to take care of the serial correlation in the error terms without adding lagged difference terms. The test can be performed using the three regression equations as in the DF test above. According to Asteriou and Hall (2007), the PP statistics are alterations of the Augmented Dickey Fuller *t* statistics that take into account the less restrictive nature of the error process. Since the asymptotic distribution of the PP *t* statistic is the same as the ADF *t* statistic the MacKinnon critical values are still applicable.

2.3.6 Correcting non-stationarity

The two basic ways for transforming non-stationary economic time series data are through differencing and detrending. The point in differencing is to come up with an Auto Regressive Integrated Moving Average (ARIMA) model of the form ARIMA (*p,d,q*) which is stationary. The parameters *p, d*, and *q* are non-negative integers that indicate the order of the autoregressive, integrated, and moving average parts of the model respectively. Detrending, on the other hand entails manipulating time series data so as to get rid of the long-term trends.

(a) Differencing

Differencing involves calculating absolute changes from one period to the next. In the event where the time series data is found to have a unit root, differencing will make such a series stationary.

Differencing is demonstrated symbolically in Asteriou and Hall (2007) as follows:

First order differencing is given by; $\Delta Y_t = Y_t - Y_{t-1}$ (equation 2.13)

If ever the differenced series still shows a trend, it then requires to be differenced again for the second, third or more times until it can be stationary.

Second order differencing ($\Delta\Delta Y_t$) is given by;

$\Delta^2 Y_t = \Delta (Y_t - Y_{t-1})$

$= \Delta Y_t - \Delta Y_{t-1}$

$= (Y_t - Y_{t-1}) - (Y_{t-1} - Y_{t-2})$ (equation 2.14)

(b) Detrending

The simplest way to deal with a non-stationary series that has a trend is to regress it on time so that the residuals from this regression will be stationary. When detrending, Gujarati and Porter (2009) recommend the running of the following regression:

$Y_t = \beta_1 + \beta_2 t + \mu_t$ (equation 2.15)

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

According to Gujarati and Porter (2009),

$\hat{\mu} = (Y_t - \hat{\beta}_1 - \hat{\beta}_2 t)$ (equation 2.16)

will be stationary where the $\hat{\mu}$ is known as a linearly detrended time series. In cases where the trend series is not linear but quadratic the residuals will be termed quadratically detrended time series.

2.3.7 Time series models

(a) The Autoregressive (AR) models

If a time series model includes one or more lagged values of the dependent variable among its explanatory variables, Gujarati (2004) terms it an autoregressive model or a dynamic model. Asteriou and Hall, (2007) regard AR (1) models as the simplest purely statistical time series model. The autoregressive of order one model commonly written as AR (1) is specified as;

13

$$Y_t = \sigma\, Y_{t-1} + u_t \qquad\qquad\qquad\qquad \text{(equation 2.17)}$$

In equation 2.17, there is no constant for the sake of simplicity and $|\sigma| < 1$ while u_t is a white noise error term. The AR (1) model above can be interpreted as the time series behaviour of Y_t which is vastly decided by its own value in the previous period. In other words, what will take place in time t largely depends on what took place in period $t - 1$. An alternative reasoning will be what will come about in time $t + 1$ is decided by the series in the current time t. Given the AR(1) model above, the condition for stationarity requires that we meet the constraint $|\sigma| < 1$, otherwise if ever $|\sigma| > 1$ then Y_t will tend to exhibit an explosive series as t increases.

Whenever a time series statistical model for an economic variable is specified, the precise nature of the process generating the time series Y_1, Y_2, Y_3…Y_T is usually not known. In AR (1) case it is assumed that the order of the autoregressive process is 1 which is to say there is only one lagged dependant variable (Y_{t-1}). Griffiths *et al.* (1993) recommend that since Y_t may not only depend on Y_{t-1} but also on Y_{t-2}, Y_{t-3} and so on, we have to introduce the statistical model of an autoregressive process of order *p*. In simpler terms, AR (*p*) is the most generalised autoregressive model where *p* represents the order of the auto regressive process, which is also the number of lagged dependant variables the model will contain. This explanation is presented below where;

AR (1) model is given as; $Y_t = \sigma\, Y_{t-1} + u_t$ (equation 2.18)

AR (2) model is given as; $Y_t = \sigma_1\, Y_{t-1} + \sigma_2\, Y_{t-2} + u_t$ (equation 2.19)

AR (*p*) model is given as; $Y_t = \sigma_1\, Y_{t-1} + \sigma_2\, Y_{t-2} + \ldots + \sigma_p\, Y_{t-p} + u_t,$ (equation 2.20)

which can simply be condensed to $Y_t = \sum_{i=1}^{p} \sigma_i\, Y_{t-i} + u_t$ (equation 2.21)

Given the AR (*p*) model Asteriou and Hall, (2007) underlined the necessary though not a sufficient requirement for stationarity which requires that; $\sum_{i=1}^{p} \sigma_i < 1$. Griffiths *et al.* (1993) demonstrate an important property of all stationary AR processes. The authors stress that AR processes can be rewritten as functions only of the random disturbance say, u_t. Still assuming that the intercept is equal to zero for simplicity, an AR (1) process;

$$Y_t = \sigma_1 Y_{t-1} + u_t, \qquad\qquad\qquad\qquad \text{(equation 2.22)}$$

holds true for all values of *t*, so that

$$Y_{t-1} = \sigma_1 Y_{t-2} + u_{t-1} \qquad \text{(equation 2.23)}$$

If equation 2.23 can be substituted into equation 2.22 we can represent Y_t as an infinite weighted sum of the uncorrelated random disturbance u_t and its lagged values u_{t-i} as shown below;

$$Y_t = \sum_{i=0}^{\infty} \sigma_1^i \, u_{t-i} \qquad \text{(equation 2.24)}$$

Any stationary AR process can be represented as in equation 2.24 above as the term $\sigma_1^i Y_{t-i}$ converges to the limit 0 when $|\sigma_1| < 1$ and the model is called the moving average representation of the AR (1) process equation 2.22.

(b) Moving Average (MA) models

While relationships of the type characterized by AR *(p)* model are prevalent in economics, Griffiths *et al.* (1993) argue that there are vast economic hypotheses that lead to another form of a time series structure called a moving average process. The simplest form of moving average model is that of order one, or the MA (1) model (Asteriou and Hall, 2007). MA (1) model can be illustrated as shown below;

$$Y_t = u_t + \emptyset \, u_{t-1} \qquad \text{(equation 2.25)}$$

The inference in the MA (1) model above is that Y_t is dependent upon the value of the immediate past error which is known at time *t.* According to Griffiths *et al.* (1993) a moving average process is one where the value of the economic variable making the dependant variable is a weighted average of a current and a past random disturbance when going back by 1, 2…*q* periods. In other words, it is a model where random shocks require more than one period to work themselves through the system.

The general form of the Moving Average model, which is denoted by MA (q), is presented in Asteriou and Hall (2007) as;

$$Y_t = u_t + \emptyset_1 \, u_{t-1} + \emptyset_2 \, u_{t-2} + \ldots + \emptyset_q \, u_{t-q} \qquad \text{(equation 2.26)}$$

The above model specification can be rephrased as:

$$Y_t = u_t + \sum_{j=1}^{q} \emptyset_j \, u_{t-j} \qquad \text{(equation 2.27)}$$

where; $ʉ_t$ is a white noise error term that fulfils all the classical assumptions. Y_t is equal to a constant plus moving average of the current and past error terms. In more general terms, Y_t follows a *q*-order moving average or a MA (*q*) process. Gujarati and Porter, (2009) give a summarised expression of a moving average process as a linear combination of white noise error terms. Supporting the same notion, Asteriou and Hall (2007) argues that, any MA (*q*) process is by definition an average of *q* stationary white noise processes, therefore every moving average model is stationary as long as *q* is finite.

(c) Autoregressive and Moving Average (ARMA) models

ARMA (p,q) models exist when Y_t has characteristics of both AR and MA such that there will be *p* autoregressive and *q* moving average terms in the process. The general form of the ARMA (*p,q*) model is given as;

$Y_t = σ_1 Y_{t-1} + σ_2 Y_{t-2} + … + σ_p Y_{t-p} + ʉ_t + ∅_1 ʉ_{t-1} + ∅_2 ʉ_{t-2} + … + ∅_q ʉ_{t-q}$ (equation 2.28)

The above can be condensed into summation form as;

$Y_t = \sum_{i=1}^{p} σ_i Y_{t-i} + ʉ_t + \sum_{j=1}^{q} ∅_j ʉ_{t-j}$ (equation 2.29)

Given the above ARMA (*p, q*) model it is known that the moving average part making the process is already stationary which is perhaps why Asteriou and Hall (2007) gave a condition for stationarity that only deals with the AR(*p*) part of the specification.

(d) Autoregressive Integrated Moving Averages (ARIMA) models

The assumption with AR, MA and ARMA models is that the process generating the series of our data exhibits constant mean and variance and its covariance is time invariant. However, in reality it is known that economic time series are non-stationary or are according to Gujarati and Porter (2009) integrated.

Therefore, a general ARIMA (*p, d, q*) model is integrated of order *d* which is to say it has to be differenced *d* times in order to make the series stationary before we can apply the ARMA (*p, q*) model to it. The *p* is still the AR term representing the number of lags of the dependant variable. The *q* is still the MA term representing the number of lagged terms of the error term. The Box –Jenkins approach to time series model building is used for finding an ARIMA model that may adequately represent the data

generation process (Griffiths *et al.*, 1993). The approach for ARIMA model building involves three stages which are identification, estimation and diagnostic checking.

(e) Vector Autoregressive (VAR) models

Real life economics present us with cases where we have simultaneity between variables. Some variables are not only explanatory for a given dependant variable but they are also explained by the variables that they are used to determine (Asteriou and Hall, 2007). Such cases are modelled by simultaneous equations that clearly distinguish between endogenous and exogenous variables though such demarcation of variables was profoundly criticised in Sims (1980). In light of Sims' (1980) argument, whenever there is simultaneity among variables then all of the variables should be treated without distinction but as endogenous. Hence, Sims (1980) came up with the vector autoregressive model which according to Griffiths *et al.* (1993) is an extension of the univariate AR *(p)* models whose seed according to Gujarati and Porter (2009) were already sown in the Granger Causality test.

2.3.8 Causality tests

According to Asteriou and Hall (2007), in econometrics sense, causality is to some extent different to how the concept is perceived in everyday use. Asteriou and Hall (2007) views the concept of causality as, the ability of one variable to predict (thus cause) the other. This view coincides with Diebold's (2001) long-winded statement that considers causality relationships in light of whether one variable contains useful information for predicting the other over and above the past histories of the other variables in the system. It is for the purpose of simplicity that Diebold (2001) reiterated the use of the phrase, "Y_i causes Y_j" (where Y_i and Y_j are the variables under analysis), to avoid the long winding nature of the sense behind the causality concept.

(a) The Granger Causality test

In trying to address the question on whether one variable is causally related to another, Granger (1969) initiated the concept of causality that has commonly gained popularity as "the Granger causality test". If a variable is said to Granger cause another, its current and past information is useful in improving the forecasts of the variable it causes.

Asteriou and Hall (2007) demonstrate how Granger causality tests for the case of two stationary variables Y_t and X_t is done in the context of VAR models as shown in equations 2.30 and 2.31;

$$Y_t = a_1 + \sum_{i=1}^{n} \beta_i X_{t-i} + \sum_{j=1}^{m} \gamma_j Y_{t-j} + e_{1t} \qquad \text{(equation 2.30)}$$

$$X_t = a_2 + \sum_{i=1}^{n} \theta_i X_{t-i} + \sum_{j=1}^{m} \delta_j Y_{t-j} + e_{2t} \qquad \text{(equation 2.31)}$$

where it is assumed that both Y_t and X_t error terms are uncorrelated and white noise such that the following would be the expected cases;

  i.   the lagged X terms in equation 2.30 may be statistically different from zero as a group and the lagged *Y* terms in equation 2.31 not statistically different from zero. In this case X_t causes Y_t

 ii.   the lagged Y terms in equation 2.31 maybe statistically different from zero as a group while the lagged X terms in equation 2.30 may not be statistically different from zero. In this case Y_t causes X_t

iii.   both sets of X and Y terms are statistically different from zero in equation 2.30 and equation 2.31 so that we have bi-directional causality

 iv.   both sets of X and Y terms are not statistically different from zero in both equations 2.30 and 2.*31* so that X_t is independent of Y_t

(b) The Sims causality test

Koop (2000) emphasizes that time never runs backward thus; past events can cause events to happen today and not vice versa. It is with this same thinking that Sims (1980) suggested an alternative causality test that basically extends from the Granger causality tests. Where the goal is to check whether Y_t causes X_t Sims proposed that the following pair of VAR model be estimated;

$$Y_t = \alpha_1 + \sum_{i=1}^{n} \beta_i X_{t-i} + \sum_{j=1}^{m} \gamma_j y_{t-j} + \sum_{\rho=1}^{k} \omega_p X_{t+p} + e_{1t} \qquad \text{(equation 2.32)}$$

$$X_t = \alpha_2 + \sum_{i=1}^{n} \theta_i X_{t-i} + \sum_{j=1}^{m} \delta_j y_{t-j} + \sum_{\rho=1}^{k} \varphi_p Y_{t+p} + e_{2t} \qquad \text{(equation 2.33)}$$

In addition to current and lagged values of X and Y the regressions above also incorporate some additional future (lead) values of the independent variables. From the first equation, if for instance Y_t Granger causes X_t then it will be anticipated that

18

there is an association between Y and the lead values of X. Hence, instead of testing that $\sum_{i=1}^{n} \beta_l = 0$ it is rather tested that $\sum_{\rho=1}^{k} \omega_p = 0$ from equation 2.32. Rejecting the hypothesis means the causality runs from Y to X and not from X to Y thus substantiating the future cannot cause the present. In carrying out the Sims test, equation 2.32 will have to be tested first without the lead terms and call it the restricted regression. Secondly, the same model will have to be tested but now with the lead terms and it will be called the unrestricted regression. The F statistic is obtained as in the Granger test scenario.

2.4 Review of previous studies on price transmission

2.4.1 Studies in South Africa

Mashamaite and Moholwa (2005) tested price asymmetry in South African futures markets for agricultural commodities using daily and weekly prices. In their study, a dynamic price asymmetry model was used to test price asymmetry in South African futures markets for yellow and white maize, wheat and sunflower seed. Upon regressing futures price changes against both positive and negative lagged price changes within the same series, it was found that only daily wheat was price asymmetric. This finding led to the conclusion that wheat daily prices respond faster to price decreases than to price increases. Failure to reject the null hypothesis of equal means between positive and negative price changes meant that the South African futures markets for white and yellow maize, wheat and sunflower seed could be price symmetric.

Kirsten and Cutts (2006) investigated asymmetric price transmission and market concentration in four South African agro-food industries. The results of the Granger causality tests on all the products under analysis confirmed that all the retail prices were caused by farm prices and not vice versa. In other words, uni-directional causality from farm to retail was detected. Through use of the error correction model, Kirsten and Cutts (2006) found asymmetry in all the supply chains they investigated. It was concluded that retail prices do not react completely within one month to the relevant producer price since all the positive and negative error correction terms were found to be significantly less than one. The one-month lag in responsiveness was attributed to the existence of wholesale prices, which were excluded in the study. It was also realized that in most cases retailers react faster when their margins are squeezed than when they are stretched as confirmed by the negative

19

error correction terms that were greater than the positive error correction terms. The study also revealed that agro-food industries that have some market concentration are likely to have high levels of asymmetric price transmission. The study however, cautions on making conclusions about price transmission of highly perishable products since asymmetry can still be lower regardless of the industry concentration.

In an analysis of costs and margins between farm and retail levels in South Africa, Funke (2006) considered five (5) food supply chains for maize, fresh milk, beef, poultry and sugar. The study established that there was a widening farm to retail price spread in commodities such as beef, milk and sugar while in maize meal and broiler meat the opposite was found. A widening farm to retail price spread was concluded to be an indication of a decline in the farmers' share of the retail price. In about 80% of the supply chains investigated, it was found that the producer price increases were not smoothly and timely transmitted to the retail price. However, the economic models used to test asymmetric price behaviour in these supply chains did not show any form of significance. Funke (2006) attributed this to factors like the presence of asymmetric price transmissions, a lack of accurate data and possible unjust marketing behaviour by role players within the supply chains.

2.4.2 Studies in Africa

In an analysis of margins, price transmission and spatial market integration in the horticultural market of Zimbabwe, Guvheya *et al.* (1998) used daily and weekly tomato price data that was collected from field surveys. With the aid of the concurrent method for calculating gross marketing margins, it was established that marketing costs accounted for a large portion of the consumer's dollar. Guvheya *et al.'s* (1998) Granger causality tests showed no causal relationship between the wholesale price and the farm price at 5% significance level. However, the study, through an analysis of the F-statistics pointed to more likelihood of prices flowing from wholesale to farm than vice versa at higher levels of significance. A bidirectional causality relationship was also established between the two levels, wholesale and retail at 5% significance level though there was greater possibility for wholesale prices causing retail prices as was confirmed by the F statistic. By employing the Houck procedure, Guvheya *et al.* (1998) found that price transmission between the wholesale and the farm was asymmetric at 10% significance level. In contrast,

evidence of symmetric price transmission was found between the wholesale and the retail levels.

Using an error correction model, Minot (2011) investigated the degree of transmission of world food prices to markets in Sub- Saharan Africa. The empirical results showed a long-term relationship between world food prices and 21% of African food prices studied. African rice prices were found to have a closer link to world prices than were maize prices. Importantly, the study revealed a 63% increase in staple food prices between mid-2007 to mid-2008, which was approximately three-quarters of the proportional rise in the world prices.

Abdulai (2000) studied spatial price transmission and asymmetry in the Ghanaian maize markets. With threshold cointegration tests, the study allowed for asymmetric adjustments towards a long run equilibrium relationships that allowed for analysis of price linkages between principal maize markets of Ghana. The empirical evidence that was generated by the study indicated a high degree of integration in major maize markets of Ghana. However, the results of the threshold cointegration and asymmetric error correction models that were used, showed asymmetry in wholesale maize price transmission between the local markets and the central markets. It was also established that local markets responded faster to increases than to decreases of wholesale maize prices at the central market.

2.4.3 Studies in the rest of the world

Mohamed *et al.* (1996) performed the Granger causality tests in examining the nature of price linkages of vegetables between farm, wholesale and retail levels in selected vegetable markets in Malaysia. Out of the eleven vegetables analysed, it was found that wholesale prices led farm prices for more than half of the vegetables in analysis. However, a unidirectional reverse causality from farm to wholesale was found in three of the vegetables while a bi directional relationship between farm and wholesale prices was also established on two types of the vegetables under analysis.

In an analysis of price transmission, Moghaddasi (2009) considered monthly price observations at farm and retail levels for two Iranian agricultural products namely pistachio and date. Results of the Granger causality tests performed, shows that the retail price of pistachio caused the farm price after three lags. This may imply that it

took about three months for farm prices to respond to shocks in retail prices. However, an opposite causation relationship was found in the date market where farm prices caused retail prices after two lags. After performing the Houck procedure, the results gave evidence of asymmetric price transmission in the market for pistachio. It was then concluded that price increases were transmitted more completely than its decreases in this market. By means of error correction model, Moghaddasi (2009) also revealed asymmetry in price transmission in the date market since price increases at the farm level were more rapidly and fully transmitted than price decreases.

Results of several studies on price transmission in agricultural markets such as Kinnucan and Forker (1987); Azzam (1999); Reziti (2005) indicated that the farm-retail price transmission process is asymmetric. This means that retail product prices in most cases adjust more rapidly and more fully to increases in the farm prices than to decreases.

In a study on dairy products, Kinnucan and Forker (1987) found that asymmetry in farm- retail price transmission resulted from industry concentration at market levels beyond the farm gate. Bolotova and Novakovic (2011) noted about five major causes of price asymmetry between levels, as revealed in several literature which include the presence of market power and coordinated conduct of firms with market power, government regulations, repricing and transactions costs, shifts in supply and demand, and imperfect information. According to Karantininis *et al.* (2011) positive price transmission occurs when agents in the intermediate stages in the food supply chain exercise market power and influence the price adjustment process to their advantage both upstream towards farmers and downstream towards the final consumer. The market structure of each level and information advantage of one level compared to another are stated in Mohamed *et al.* (1996) as determinants of the efficiency of price transmission between the two levels.

Girapunthong *et al.* (2004) explored price asymmetry in the United States fresh tomato market. In an effort to analyse price relationships between the farm, wholesale and retail levels of this industry, the authors employed the Ward's (1982) price asymmetry model. Granger causality tests were used first to determine the direction of causality. It was then established that price transmission was unidirectional from the farm to the retail level. The study did not find any asymmetric

22

response in price transmission between producers and retailers. However, evidence of price asymmetry was found between wholesalers and both producers and retailers. Such evidence was interpreted to indicate retail prices responding more to increasing wholesale prices than to decreases. On the other hand wholesale prices were found to react more to decreasing producer prices than when they rise.

2.5 Conclusion

The chapter has explored the concepts of marketing margins, price determination, price transmission and time series analytical techniques. Selected work by a number of authors has been reviewed to demonstrate how the subject of vertical price transmission has been tackled in South Africa, Africa and elsewhere in the world. The next chapter provides an overview of the tomato industry in South Africa.

CHAPTER 3: OVERVIEW OF TOMATO INDUSTRY IN SOUTH AFRICA

3.1 Introduction

This chapter gives an overview of the tomato industry environment in South Africa. Special emphasis is made on the marketing environment in which the Limpopo Province's tomato producers operate. The chapter commences by giving a general outlook on the country's tomato industry as a whole. An expressive mapping of the tomato industry situation in Limpopo Province is outlined. The chapter then progresses by explaining the relationship between and roles of the various players in the marketing chain of tomato in the Limpopo Province.

3.2 The tomato industry in general

Tomato is one of the most produced and consumed vegetable crops in South Africa. According to DAFF (2010), tomato is South Africa's second most important and popular vegetable crop after potatoes. Tomato is not only cultivated commercially but is also grown by subsistence, resource poor farmers and home gardeners. Although tomato is produced in almost all provinces of South Africa, Limpopo Province is the main producer. Comparing the national tomato land allocation figures (provided by the National Department of Agriculture in the production guidelines for tomato), with the 3590 ha which according to DAFF (2011) is the Limpopo Province's land allocation to tomato, it follows that the province accounts for more than 50% of the total national area planted under tomato. Coming second to the Limpopo Province is Mpumalanga Province and thirdly, the Eastern Cape Province with land allocations to tomato production of 770ha and 450ha respectively. Since tomato is a warm season crop, its production is limited in winter months though some farmers undertake production in frost free areas or under controlled environments in tunnels and green houses.

Table 3.1 shows the importance of tomato by comparing tomato production and the production of other selected vegetables in South Africa for the period 2006/07 to 2010/11. The table shows that vegetable production has been on an upward trend as of 2008 to 2011. The most recent recorded increment in vegetable production was from 2009/10 to 2010/11 seasons, where the total production of vegetables (excluding potatoes) increased by about 1.0%. However, during the same period, tomatoes realized a fall in the total production by about 9.2% in contrast to the DAFF (2010) recorded increase of 13.8% in 2009 from the 2008 figures.

Table 3.1: Production of selected vegetables in South Africa (2006/07 to 2010/11)

Year	2006/07	2007/08	2008/09	2009/10	2010/11
	'000 tons				
Tomatoes	528	500	515	575	522
Onions	475	445	472	489	564
Green mealies	319	324	337	339	340
Cabbages	146	150	141	141	154
Pumpkins	232	230	229	234	237
carrots	146	144	164	151	152
other	543	563	570	592	581
Total	2 389	2 356	2 428	2 521	2 550

Source: DAFF (2012)

Nevertheless, for the 5 years represented in the table, tomato production has sustained a stable trend with fluctuations within the range of 500 000 tons to 575 000 tons. The highest production volume was recorded in 2009/2010 and the drop in production in 2007 was explained in DAFF (2010) as to have been due to unfavourable climatic conditions and high production costs within that season.

As at 2010, tomato added up to about 20% to the gross value of vegetable production in South Africa (DAFF, 2011). The South African tomato subsector is also a great contributor to the national economic statistics. The industry employs about 22 500 people who jointly have at least 135 000 dependents (DAFF, 2010). Comparing these employment figures with the ones given by Cronje (2010) the tomato subsector was by 2010 responsible for about 3.2% of the total number of jobs in the agricultural sector of the country.

South Africa is self-sufficient in tomato production. DAFF (2012) points to the geographic distribution nature of tomato production that a sufficient volume of the crop is always produced to meet the daily demand. In all the years, it has been observed that the total production fairly exceeds local consumption, with the surplus being exported. As such, the tomato industry contributes to international trade and towards an improved balance of payments for the country.

Figure 3.1 shows the percentage production gross value of tomatoes against other major vegetable types for the period July 2010 to June 2011 in South Africa.
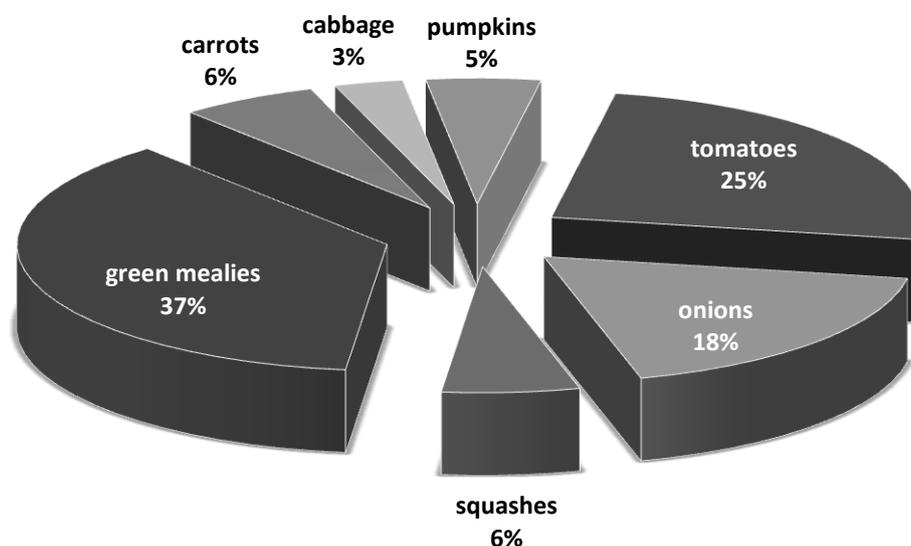
Figure 3.1: Percentage production gross value of tomatoes against other major vegetable types 2010/11 in South Africa

Source: DAFF (2012)

During the 12 months ending in June 2011, tomatoes were the second most important vegetable in terms of contribution to gross value of production in the vegetable subsector in South Africa. However, DAFF (2012) indicates that the gross value of production decreased slightly by 0.4% to R1 549 million when tomato production fell to approximately 521 776 tons during 2010/11 season.

3.3 Structure of the tomato industry

Figure 3.2 portrays several marketing options available to Limpopo tomato farmers. The figure also shows the network of players that make up the structure of the tomato industry in Limpopo Province of South Africa.

Retailing — } Shoprite, Checkers, Pick n Pay, Goseame Open Market, Fruit and Veg City, Wool Worth's, etc.

NFPM — } Joburg, Tshwane, Durban, Cape Town, Bloemfontein, Kimberly, etc.

Exporting

Formal channel

Wholesaling

Category managers and Distribution Centres — } Fresh Mark, Pack Fresh, Fresh line, South Rand Distribution Centre, Food Hold Distribution Centre, etc.

Marketing options available to farmers

Local trading

Direct wholesaling

Institutions — } Government Departments, Hospitals, Schools, Universities, Corporations, etc.

Informal Channel

Hawkers

Hospitality industry — } Hotels, Restaurants, Fast Foods, Special Events, Lodges, etc.

Processing

Bakkie- operators

Households

- Ashton canning
-Rhodes Fruit Farms
- Miami Canners
- Giant Canners
- SAD
- Montina
- Indemex
- Tiger Brands
- Agro-processors of Limpopo (APOL)

Sphaza shops

Direct to households

Figure 3.2 Illustrative mapping of the marketing options available to tomato farmers in Limpopo Province

Source: own design

27

It is depicted in Figure 3.2 that three marketing options are available to Limpopo Province's tomato farmers. Firstly, tomato growers can target international markets through exportation. Some farmers may transform their tomatoes and sell them in processed form as in the case of farmers under the Limpopo Tomato Growers Association (LTGA). Thirdly, farmers may resort to local trading of their produce in its raw state. Under the local trading option, farmers are presented with two broad channels through which they can sell their tomatoes namely, the formal and the informal channels. Details on these production and marketing choices are discussed in the sections that follow.

3.3.1 Production of Tomato

According to Louw *et al.* (2006), the market changes in the agricultural sector of South Africa since 1994 have brought about market concentration in the agro-food sector, as dominant market players tend to favour suppliers who can ensure and sustain high volumes and consistent quality. In the case of tomato, Sautier *et al.* (2006) indicate that only four tomato producers account for about 80% of the total tomato volume in the whole country. DAFF (2010) also confirms the presence of high concentration in the tomato industry where the commercial sector contributes about 95% of the total produce while the emerging sector contributes only 5%.

There is evidence of dualism in the tomato production sub-sector of Limpopo Province, which comprises a well-developed commercial farming sector that exists concurrently with a large number of small-scale farmers. There exists only one major producer (ZZ2) that accounts for the majority of the province's total tomato production and market share.

ZZ2 is a privately owned farming conglomerate that not only operates in Limpopo Province but also in Western Cape and Eastern Cape. In the Limpopo Province ZZ2 operates in Mooketsi, Politsi, Polokwane and Musina while it also has operations in Ceres and Riebeek-Wes in the Western Cape as well as in Langkloof in the Eastern Cape provinces of South Africa. ZZ2 products range from tomatoes, onions, avocados, apples, pears and beef. However, tomatoes are their main crop which is produced all year round. ZZ2 officially existed from as far back as 1903 and it began tomato production from 1953. At present, they produce about 160 000 tonnes of

tomatoes annually, which affords them the position of a world leader in tomato production. (ZZ2, 2013).

Limpopo Provincial Government Department of Agriculture (2008) estimated that, there were 2 500 commercial and emerging tomato farmers in Limpopo Province under the organization of a commodity group called The Limpopo Tomato Growers Association (LTGA). The semi-structured interviews carried out with the Chairperson of LTGA, indicated that the organization's membership has decreased over the years. Since its inception in 2000, the organization has lost more than 50% of its membership due to concerns regarding inability of the commodity group to meet their short-term expectations. Such challenges may perhaps explain why ZZ2 which is the largest tomato farmer in the province has never been a member of LTGA since its establishment.

Despite the challenges the LTGA has gone through in the past 12 years of its existence, the organization has attained some notable achievements for its loyal members. Firstly, the LTGA ensured a guaranteed market for its members' produce through establishing a jointly owned canning factory Agro-processors of Limpopo (APOL) in Tzaneen. The organization has also managed to improve and secure an efficient transport facility for the members to be able to ferry their produce to the factory with minimal difficulties. LTGA also assisted its members access to the Land Bank's no collateral loans a move which assisted many with bridging the capital gap in both production and marketing. LTGA is also an important player in the price discovery process as it negotiates on behalf of its members for lucrative prices of their produce.

3.3.2 Marketing of Tomato

The players in tomato marketing in the Limpopo Province include farmers, exporters, local traders and processors as shown in Figure 3.2.

Local traders can fall in either the formal or the informal sector. The formal sector comprises mainly wholesalers and retailers. Retailers are formally registered supermarket chains, department stores and hypermarkets. The major retailers involved in the trading of tomatoes in the province include Shoprite, Checkers, Goseame Open Market, Fruit and Veg City, Spar, Woolworths and Pick n Pay. Sometimes these retailers buy directly from farmers, while they at times supplement

their supply from the Tshwane and Johannesburg fresh produce markets. Some of them procure fresh produce through their commodity managers or buying agents who make crucial buying decisions.

Three forms of wholesaling were identified to be in existence in the Limpopo Province. The National Fresh Produce Markets (NFPMs) are firstly, the prevailing player and a major type of wholesaling for the Limpopo tomato subsector. Most commercially produced tomato in the province is sent in bulk to NFPMs in the major cities like Johannesburg, Pretoria, Cape Town, Durban, East London, Port Elizabeth, Bloemfontein, Welkom, Vereeniging, Kimberley, Klerksdorp, Nelspruit and Pietermaritzburg. The second form of wholesaling identified in the province is the one where farmers sell directly in bulk to retailers, informal traders and households (especially for events). Limpopo's tomato producers also enjoy the bulky patronage of several institutions as their clientele such as government departments, hospitals, boarding schools, universities and other private corporations. Also as part of the client base, the Limpopo Province tomato farmers sell in bulk to the hospitality and catering companies such as hotels, restaurants, fast foods and lodges.

Thirdly, bulk transactions occur in the province between farmers and category managers as well as buying agents for several Distribution Centres (D.Cs). Category managers or captains are supply management corporations who break down the range of products sold by a retailer into discrete groups of similar or related products for instance, fresh produce. Examples of category managers and buying agents who purchase Limpopo tomatoes are Freshmark, Fruitspot, Mr Veg, Freshline, etc. Distribution centres are short-term storage centres located close to the major retail market outlets to facilitate the rapid processing of orders and shipment of fresh fruit and vegetables to the various supermarket stores in the region (Louw *et al.,* 2007). Examples of D.Cs are Spar South Rand Distribution Centre, Foodhold Distribution Centre, Freshmark DC Polokwane, etc.

The informal tomato-trading option on the other hand consists of hawkers (roadside and pavement traders), tuck shops (*sphazas*), and roamers (bakkie operators). Hawkers are vegetable vendors who sell amongst other things tomatoes on the pavements, roadsides or stalls built by the city authorities. In South Africa, tuck shops, also known as *sphaza* shops are convenient shops usually run from homes,

which sell almost everything in small quantities. Amongst a wide range of their small stock, *sphazas* also sell foodstuffs that mostly are used by households on a daily basis such as tomatoes, onions and other vegetables. Both hawkers and *sphaza* shop operators usually stock from the farms in smaller bulk e.g., crates or sometimes are supplied by truck operators. The third type of informal traders are the more mobile truck/ bakkie operators who drive their own vehicles to the farms and purchase in bulk (to the limit of their vehicles' capacities), then move around cities, townships and villages chanting or ringing the horn to attract the attention of potential buyers.

The other players that play a critical role in tomato marketing in Limpopo Province are processors. In South Africa tomato processing is classified into, canning, freezing, dehydration and juice production. The range of products into which tomatoes can be processed is given in DAFF (2010) as; whole pealed, tomato and onion bruises, pasta, shredded, puree and pasta concentrate. The Limpopo Province plays a very important role in tomato processing and according to Tomato Land (2012), Tiger Brands processes most of the tomatoes at its Messina factory. Processors are supplied directly from farms and sometimes procure from the NFPMs. The Limpopo Province supplies amongst major South African processors not only Tiger Brands but also Miami Canners, Giant Canners SAD, Montina, Indemex, Rhodes Fruit Farms, Agro-processors of Limpopo (APOL), etc.

Condensing the activities of all players that make up the tomato industry of the Limpopo Province, at least 6 marketing channels can be identified as depicted in Figure 3.3 which include;

1. Farmers ⟶ Consumers

2. Farmers ⟶ Informal traders ⟶ Consumers

3. Farmers ┅┅▶ Retailers ┅┅┅▶ Consumers

4. Farmers ⟶ Category managers ⟶ Retailers ⟶ Consumers

5. Farmers ⟶ Processors ⟶ Wholesalers ⟶ Retailers ⟶ Customers

6. Farmers ┅┅▶ NFPMs ┅┅▶ Retailers ┅┅▶ Consumers
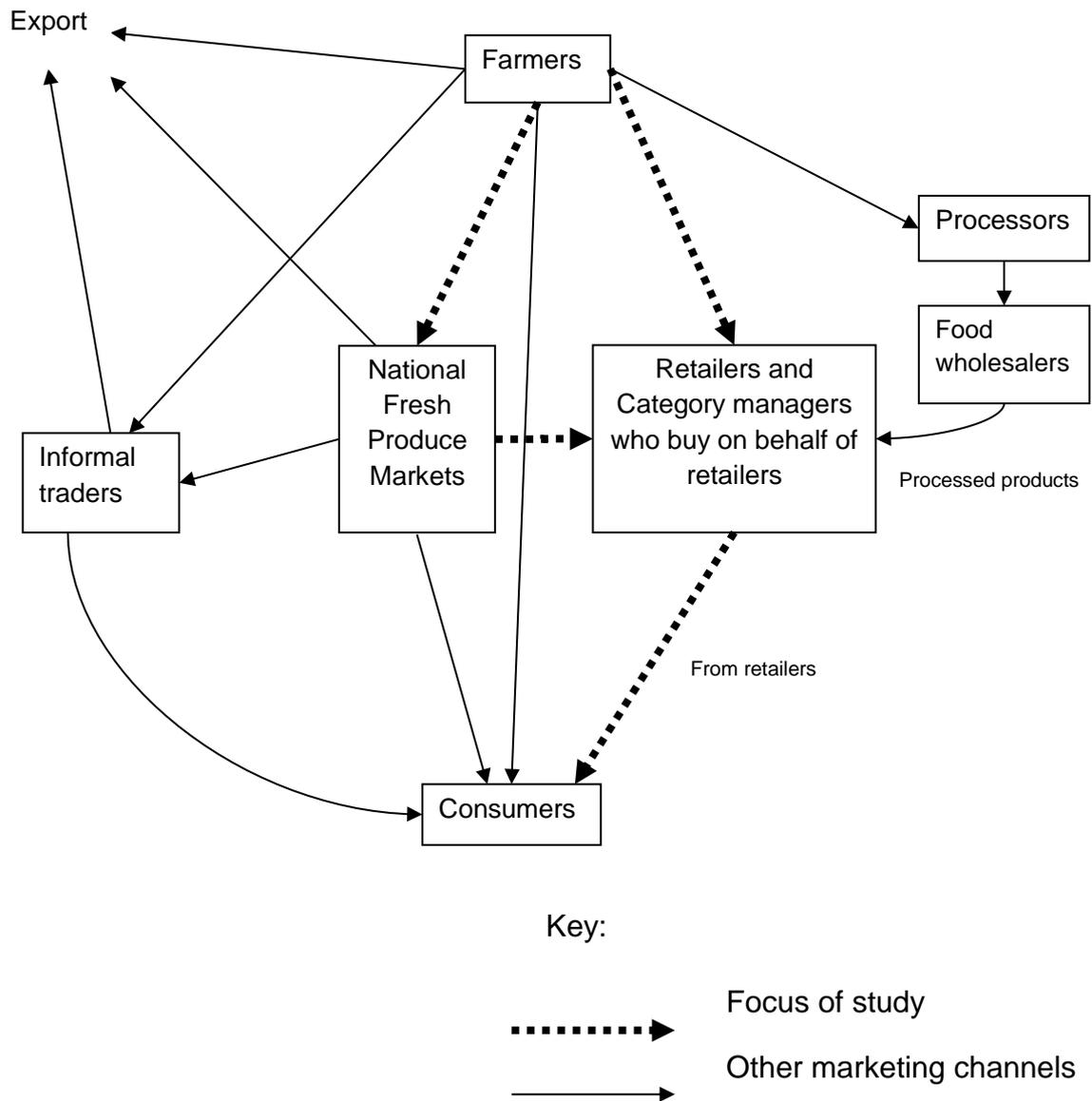
Figure 3.3: Marketing Channels for Limpopo Province's Tomatoes

Source: own design

As countries develop, marketing channels become more complex and new ones emerge (Dixie, 2005). According to Chikazunga *et al.* (2008), South African farmers have a varied choice of market options since the distribution channels in the country are diversifying, which is evident in Figure 3.3.

3.4 The National Fresh Produce Market channel

NFPMs are according to DAFF (2010), the dominant player and form of wholesaling in the South African tomato and fresh fruit and vegetable sector. From their review of

statistics and market observations Chikazunga *et al.* (2008) also consent that municipal fresh produce markets are by far the dominant players and form of wholesaling in the South African fresh fruit and vegetable sector. Even though NFPMs' biggest competition is that of sales direct to retail, they are still the major suppliers of fresh produce to chain retailers, exporters, processors, informal traders and other wholesalers. National Agricultural Marketing Council (NAMC) (2006) also regards the NFPMs to be integral, even though a diminishing part, of the price-making, distribution and marketing of fresh produce in South Africa.

Owing to the vital role of NFPMs in tomato marketing in South Africa, this study therefore focused on the channels indicated by broken arrows (see Figure 3.3). However, it is recognized that NFPMs have in recent years suffered stiff competition as informal traders, supermarkets, retailer-wholesalers and processors have adopted strategies where they sometimes procure directly from farmers.

In historical times, some Limpopo farmers would market their produce at the Pietersburg National Fresh Produce Market (PNFPM) amongst other markets. PNFPM was given the status of a national fresh produce market in May 1995 and was officially launched in December the same year by the Premier of the Northern Province. However, the market did not perform very well compared to other fresh produce markets in the country. Consequently, the market had to, according to NAMC (2006), close its doors to business around 2005/06. This left Limpopo farmers with the options to market their produce directly to consumers, retailers, category managers or to send their produce to other FPM in other towns.

In the view of Fresh Produce Markets as an important channel of marketing tomatoes in South Africa, it is important therefore to look into the distribution of market share amongst the fresh produce markets of the country. Figure 3.4 shows the distribution of tomato sales amongst the 19 fresh produce markets in South Africa;
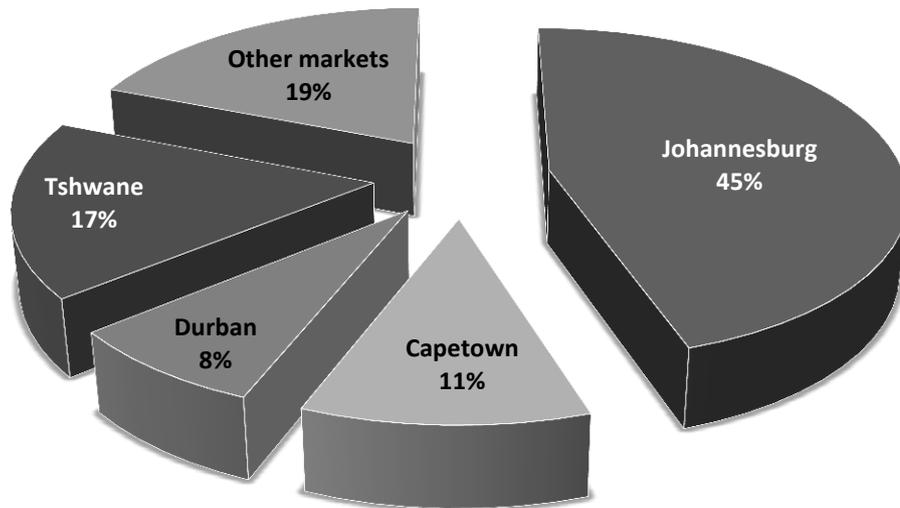
Figure 3.4: Tomato sales on the major fresh produce markets 2010/11

Source: DAFF (2012)

Figure 3.4 shows that, the Johannesburg fresh produce market is significantly the most dominant tomato wholesaler compared to other NFMs in South Africa. As such in this study much attention was paid to the Johannesburg market prices as the tomato wholesale price benchmark. From Figure 3.4, the four-firm concentration (CR4) ratio can be calculated at 81% (which is 45 +11+17+8) indicating high industry concentration amongst the major fresh produce markets for tomato. This also means that out of all the fresh produce markets in the country only four own a major stack of the market share. In other words, the fresh produce markets for tomato in South Africa are highly concentrated.

According to DAFF (2012), tomato sales on fresh produce markets and direct sales constitute approximately 69.2 % of the total volume of tomato sales in the country. However, it was noted that the magnitude of tomatoes traded on the 19 major fresh produce markets of South Africa decreased by 0.2%, between 2009/10 and 2010/11 seasons. Consequently and on a downward trend was the average price of tomatoes sold on the major fresh produce markets which registered a 4.1 % decrease from the 2009/10's R4 437.00 per ton to R4 269.07 per ton in 2010/11. Such a relationship between volume of produce and the price alarms to the high price risk associated

with this commodity due to large seasonal price fluctuations connected to its marketing.

3.4.1 Operations at the Johannesburg Market

The Johannesburg Market, whose history can be traced from as back as the 18th century, is in the present day central to the trading of fruit and vegetables not only in South Africa but also in the Southern African Development Community region. This commission market for fresh produce was corporatized in July 2000 with the City of Johannesburg no longer the sole owner but the main shareholder. The Johannesburg market is open to not only tomato producers but also all fresh producers from across South Africa. As such, the market receives an amount exceeding 1 million tons of fresh produce every year. This form of wholesale market for tomato uses the willing buyer system and as a result, does business with thousands of buyers. The market has grown quite remarkably since inception from an annual turnover of about R1.5 million around 1913 to over R 3.5 billion currently. (Joburg Market, 2012).

Tomato sales are made possible through the services of 14 market agents who also enjoy the services of over 200 sales representatives. Tomato producers will have to choose any of the market agents to whom they can deliver their produce. Upon receiving the consignment and all paperwork completed, the agents then take the produce to the commission floor where they sell it on behalf of their respective producers. The organization of the Johannesburg market does not give room to any transactions taking place between the agents and the customers anywhere else but only on the sales floors through the commission system. Therefore, the only place agents can meet buyers on business grounds is the commission floor where the actual trading takes place. Even though the Johannesburg market sells mainly in bulk through its commission system, single unit purchases are also possible to clients wishing to purchase tomatoes in smaller quantities such as a box (Joburg Market, 2012).

The commission system the market employs allows the market agents to receive a negotiable commission on the gross value of the commodities sold. For any product transacted on the market, an agent will have to negotiate with the producer for a commission that ranges from 5% to 7.5%. The Johannesburg Market on the other

hand manages, maintains a competitive marketing system and infrastructure as well as providing value adding services for a non-negotiable commission payment of 5% on the total amount of produce sold (Joburg Market, 2012).

It is also important to note that under this commission system, market agents do not assume ownership of the tomatoes or any other produce that farmers deliver to them. Rather, all produce remains the property of the owners (producers) until they are sold. Even though the produce remains a possession of the producer until it is traded, the Johannesburg market has its own managers and supervisors who undertake routine follow-ups on stock control. Such follow ups are exercised from the time producers' consignments are entered onto the market's central computerized system. In addition, to ensure security the market has in place marking requirements to address produce traceability. Under this system, all produce is marked with a Food Business Operation (FBO) code in addition to other identifications such as name and address of the producer, exporter or owner of the container. All these efforts were instituted to reinforce the traceability of produce also for food safety, quality, sanitary and phytosanitary reasons. Still as a matter of ensuring security of the producers' commodities, the market is implementing an innovative new technology interface between its finance and administration. The new technology seeks to improve product traceability not only for producers but also for buyers (Joburg Market, 2012).

3.5 Tomato retailing in Limpopo Province

Some large retailers in Limpopo Province such as Shoprite/Checkers have developed a strategy where they outsource their fresh produce procurement to category managers or distribution centres nationwide. Under such a development, retailers enter into growing programs with selected suppliers who then deliver to wholesale distribution centres where the fresh produce is repackaged before it is delivered to their respective shops. Other retailers such as Goseame Open Market and Fruit and Veg City use their own trucks to procure directly from farms but sometimes supplement with purchases from the Johannesburg and Tshwane Fresh Produce Markets during periods of scarce supply locally.

This study's findings on tomato purchasing concur with Louw *et al.'*s (2007) findings on fresh produce procurement strategies applied by selected major retailers in

Limpopo Province. Pick n Pay has a centralized procurement system where Foodhold Distribution Centre (FDC) buy from a few accredited producers with supplements from the National Fresh Produce Markets. Shoprite/ Checkers procures from a large number of suppliers through its category manager, Freshmark who also supplements where necessary from NFPMs. Spar procures some of their fresh stock from their regional distribution centres for the Freshline brand through South Rand Distribution Centre in Johannesburg. This distribution centre is a bulk buyer with the ability to negotiate for lower prices as it procures directly from approved suppliers. Spar also enjoys the services of buying agents for example; Mr Veg and Pack Fresh who again obtain fresh produce from accredited farmers. Fruit and Veg City have two procurement strategies; buying directly from smallholder farmers for economic empowerment of local communities and also from the NFPMs.

3.6 Conclusion

The province's tomato primary industry has the majority of its market share controlled by a few well established producers which is some evidence of an oligopoly. Oligopolistic competition is also evident at the wholesale marketing stage, which is highly concentrated with the CR4 ratio exceeding 80%. However, the retail sector may be regarded monopolistic given the large number of sellers (operating either formally or informally) who differentiate tomatoes through packaging and branding. Overall, this chapter has managed to provide a descriptive analysis of the tomato industry in Limpopo Province. The next chapter will focus on the description of study area and methodology applied in this study.

CHAPTER 4: DESCRIPTION OF STUDY AREA AND METHODOLOGY

4.1 Description of study area

This study is based mainly on the Limpopo Province of South Africa. Limpopo Province is the northernmost province of South Africa covering a total surface area of 123,910 km^2 making it the fifth largest province amongst the country's nine provinces. Named after the Limpopo River that flows along its northern border, the province is made up of five districts namely Mopani, Capricorn, Vhembe, Waterberg and Sekhukhune of which the capital is Polokwane in Capricorn district. Limpopo Province borders the countries of Botswana to the west, Zimbabwe to the north and Mozambique to the east. Limpopo Province has a population of about 5 554 657 people and accounts for 10.98% of South Africa's total population. The province has three principal languages which are; Sepedi, spoken by 52.1%, Tshivenda, spoken by 15.9% and Xitsonga, spoken by 2.4 % (vanNiekerk, 2012).

Limpopo Province can be described as the garden of South Africa due to its rich fruit and vegetable production. Apart from being South Africa's main tomato producer Limpopo Province is responsible for about 75% of the country's mangoes, 65% of its papayas, 36% of its tea, 25% of its citrus, bananas, and litchis, 60% of its avocados, 285 000 tons of potatoes, and 35% of its oranges. Most of tomato production in the province is done by ZZ2, the largest tomato farmer in South Africa. The province is also involved in the production of coffee, nuts, guavas, sisal, cotton, tobacco, sunflower, maize, wheat, grapes and timber. Livestock production and game ranching is also prominent particularly in most of the higher-lying areas (vanNiekerk, 2012; Limpopo Tourism and Parks Board, 2011).

Besides rich soils for agriculture, Limpopo province has plentiful mineral resources which make the mining sector important to the province. The following minerals and reserves are found in Limpopo Province; platinum, chromium, nickel, cobalt, vanadium, tin, limestone, uranium clay, antinomy, phosphates, fluorspar, gold, diamonds, copper, emeralds, magnetite, vermiculite, silicon, mica, black granite, corundum, feldspar and salt. The province is also a beautiful tourist destination due to its rich nature reserves, striking scenery and a wealth of historical and cultural treasures. To add more, Limpopo Province is an ideal place for trade and investments due to its well-developed infrastructure such as a network of rail and

road corridors that connect to major sea ports and international borders (vanNiekerk, 2012).

DAFF (2010) regards the National Fresh Produce Markets as the preferred marketing channel for tomatoes in South Africa. The Johannesburg Fresh Produce Market (JFPM) is the biggest, enjoying a market share of about 43% and Limpopo Province is a major tomato supplier to this market. Hence, the JFPM forms part of the marketing channel investigated owing to its role in providing the wholesale market for Limpopo Province's tomatoes.

4.2 Data collection

This study used both primary and secondary data of time series in nature. Primary data on daily tomato prices was collected simultaneously at farm gate and retail levels. Mixed grades of cooking tomatoes were considered for the study. The survey ran for the period from 23 May 2012 to 31 July 2012 (excluding weekends) to achieve a sample size of 50 observations.

Farm gate prices are the prices received by farmers for their produce; therefore these were collected through observations at the ZZ2 Mooketsi market from where the majority of the tomatoes in the Limpopo Province are dispatched at farm gate level into the formal channel. ZZ2 was chosen to participate in this study based on the following reasons; it is the only producer who is an all year round active supplier to the focused marketing channel of this study; it is as well the dominant producer whose isolated influence to tomato prices is also of interest to the study; it is not only a major tomato producer but its production level doubles the total production of all other farmers in the province combined.

Retail prices, otherwise known as consumer prices are those that are received by retailers from sale of tomatoes or what consumers pay when buying tomatoes from the retail merchants. Five major retailers were identified in the provincial capital city, Polokwane. Retail prices were observed and collected from all of the five. These retail merchants who are important in selling tomatoes in the Limpopo Province are Shoprite, Pick n Pay, Checkers, Fruit and Veg City, Spar and Goseame Open Market.

Due to the absence of an active wholesale market within the borders of Limpopo Province, the study considered the JFPM daily tomato prices as a proxy variable for wholesale prices. The data, being secondary in nature was obtained from the Johannesburg Market to where ZZ2 is a major tomato supplier.

Semi structured interviews and desk studies were also conducted to explore the procurement and marketing procedures followed by various participants in tomato marketing in the Limpopo Province. These interviews were conducted with the chairperson of LTGA and fruit and vegetable section managers/supervisors of Shoprite/ Checkers, Pick n Pay, Goseame Open Market, Fruit and Veg City and Spar.

4.3 Data analysis and analytical techniques

An overview of the tomato industry in South Africa was done through illustrating and discussing an expressive mapping of the industry. In the process concentration ratios were also calculated to guide the judgment on the industry's structure. Marketing margins were analysed by relating tomato price differences at different marketing levels. Econometric Views (E- Views) version 7.1 was used for analysing price transmission.

4.3.1 Marketing Margin Analysis

In analysing the marketing margins, the Concurrent Margin Method was used. As described by Singh (1998) the method is a static analysis of the distributive margin usually adopted to calculate the price spread in one market town by considering differences between prices prevailing at successive stages of marketing at a given point of time.

The model is defined as thus;

$M_t = P_{t,L} - P_{t,L-1}$ where;   (equation 4.1)

M_t= Marketing margin between market level (L) and its preceding level (L-1) at
        time (t)

$P_{t,L}$ = Price at market level (L) at time (t)

$P_{t,L-1}$ = Price at market level (L-1) at time (t)

Where marketing margins at different levels of the marketing chain are compared, Guvheya *et al.* (1998) emphasizes the use of consumer price as the common denominator for all margins.

The two indices that were used in this study are Total Gross Marketing Margin (TGMM) and Producers' Gross Marketing Margin (GMM$_p$) as given in Scott (1995) where Gross Marketing Margin is the difference between consumer's price and farmer's price. TGMM and GMM$_p$ were calculated as;

$$\text{TGMM} = \frac{Consumer\ Price - Farmer's\ Price}{Consumer\ Price} \text{ x 100, and} \qquad \text{(equation 4.2)}$$

$$\text{GMM}_p = \frac{Price\ paid\ by\ the\ consumer - Gross\ Marketing\ Margin}{Price\ paid\ by\ the\ Consumer} \text{ x 100} \qquad \text{(equation 4.3)}$$

### 4.3.2 Conceptual framework for analysing price transmission
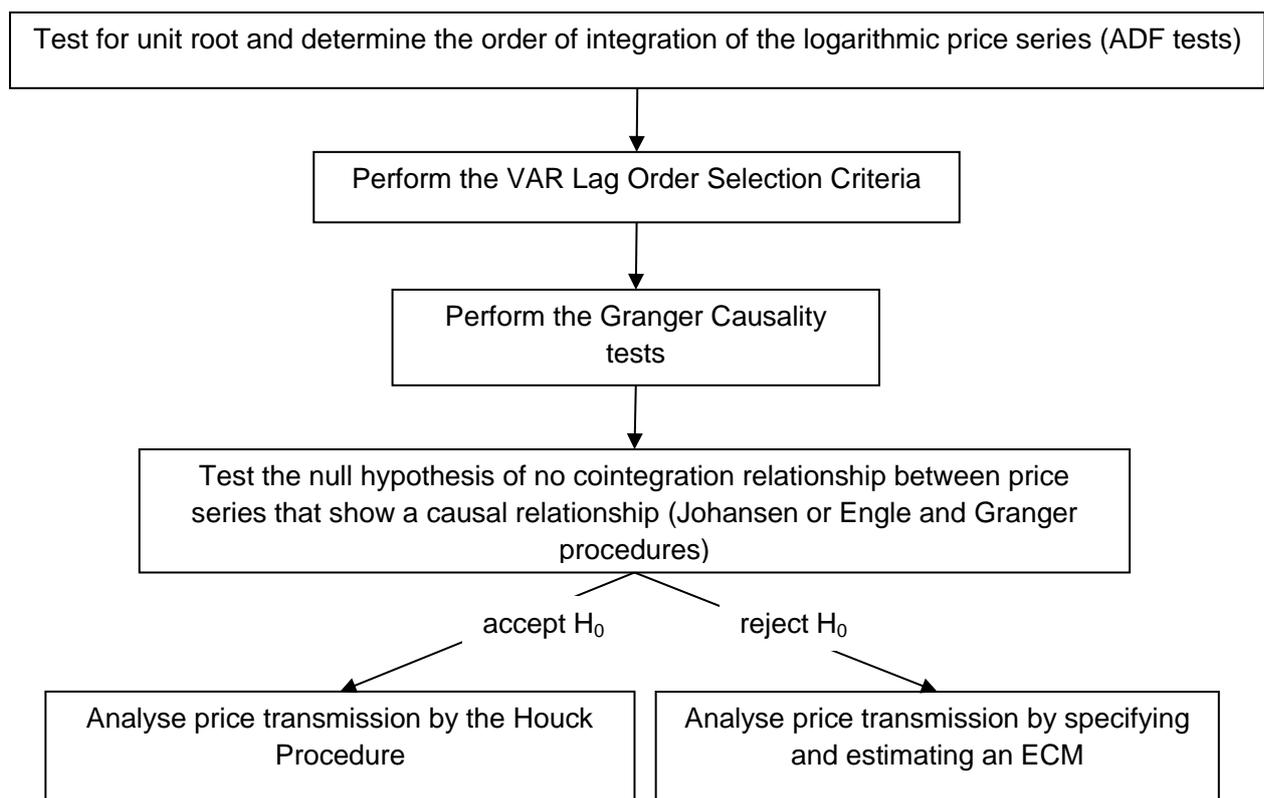
Figure 4.1 Framework for analysing price transmission

Source: own design

Figure 4.1 illustrates a conceptual framework applied to this study in analysing price transmission in tomato markets of the Limpopo Province. Firstly, each pair of logarithmic price series was examined for order of integration using the Augmented Dickey-Fuller tests (Dickey and Fuller, 1979). This was done to ensure that the price series had the same order of integration which is one of the pre-requisites for applying the error correction model. The VAR Lag Order Selection Criteria was then employed to determine the optimal lag length prior to performing Granger causality tests (Granger, 1969). Determining the optimal lag length before performing Granger causality tests is important since it facilitates the correct specification of the VAR model. Cointegration tests were done to check the presence of any long run cointegration relationships between the price series. In the event of any price series found to be cointegrated, price transmission would be analysed using the Error Correction Model otherwise, the Houck procedure would be applied. While the Houck procedure is usually preferred for its simplicity, it is usually applied without ample consideration to time series properties of data which leads to unreliable inferences when the price series are cointegrated.

4.3.3 Testing for unit root non-stationarity

The Augmented Dickey Fuller test was performed on each of the logarithmic series of farm prices (FP), wholesale prices (WP) and retail prices (RP) to formally ascertain whether they contained a unit root. According to Vavra and Goodwin (2005) a variable contains a unit root or is *I (1)* if it is non-stationary. LÄutkepohl and Xu (2012) encourage the use of time series variables in their logarithmic transformations when doing economic analysis. Stockton *et al.* (2010) also concurs to logarithmic transformation of price data as it reduces the magnitude of the variations without changing the overall appearance and characteristics of the data.

Three autoregressive forms of models were set up, each for the three respective data series of FP, WP and RP in the manner demonstrated below:

$\Delta ln\text{FP}_t = \delta_1 + \delta_2 t + \emptyset \ ln\text{FP}_{t-1} + \sum_{i=1}^{p} \text{ß}_i \Delta ln\text{FP}_{t-i} + e_t$

$\Delta ln\text{WP}_t = \delta_1 + \delta_2 t + \emptyset \ ln\text{WP}_{t-1} + \sum_{i=1}^{p} \text{ß}_i \Delta ln\text{WP}_{t-i} + e_t$

$\Delta ln\text{RP}_t = \delta_1 + \delta_2 t + \emptyset \ ln\text{RP}_{t-1} + \sum_{i=1}^{p} \text{ß}_i \Delta ln\text{RP}_{t-i} + e_t$ \hfill (equation 4.4)

Where; δ_1 = an intercept term,

t = a trend term,

lnFP$_t$ = natural logarithm of farm gate price series to be tested,

lnFP$_{t-1}$= natural logarithm of farm gate price series lagged by 1 period,

$\sum_{i=1}^{p} ß_i \Delta lnFP_{t-i}$ = the 1st, 2nd…pth lagged 1st-differenced values of lnFP,

lnWP$_t$ = natural logarithm of the wholesale price series to be tested,

lnWP$_{t-1}$= natural logarithm of wholesale price series lagged by 1 period,

$\sum_{i=1}^{p} ß_i \Delta lnWP_{t-i}$ = the 1st, 2nd…pth lagged 1st-differenced values of lnWP,

lnRP$_t$ = natural logarithm of the retail price series to be tested,

lnRP$_{t-1}$= natural logarithm of retail price series lagged by 1 period,

$\sum_{i=1}^{p} ß_i \Delta lnRP_{t-i}$ = the 1st, 2nd…pth lagged 1st-differenced values of lnRP,

δ_2, ø,ß$_i$ are coefficients

e$_t$ = a stochastic non-auto correlated error term with zero mean and a
    constant variance.

In each of the cases above, the null hypothesis H$_0$: ø = 0 (unit root) was tested with the alternative hypothesis specified as H$_1$: ø < 0 (time series is stationary). The decision rule that guided the test required that the null hypothesis be rejected only if the Augmented Dickey Fuller test statistic < MacKinnon critical values. Rejecting H$_0$ would imply that the process that generates FP series of data is time invariant (i.e. FP is stationary); otherwise the series would be non-stationary raising the need to difference the data to get rid of the unit root.

4.3.4 Price determination and direction of causality

In assessing the points of price determination and the direction of causality along the major marketing channels for tomato in Limpopo Province, Granger causality tests (Granger, 1969) were performed.

Three sets of Vector Autoregressive (VAR) models were formulated and estimated;

(a) Testing causality between farm gate and wholesale levels:

lnFP$_t$ = α$_1$ + $\sum_{i=1}^{n} a_i ln$WP$_{t-i}$ + $\sum_{i=1}^{n} b_i ln$FP$_{t-i}$ + U_{1t}

43

$ln\text{WP}_t = \alpha_2 + \sum_{i=1}^{n} c_i ln\text{WP}_{t-i} + \sum_{i=1}^{n} d_i ln\text{FP}_{t-i} + U_{2t}$ (equation 4.5)

(b)Testing causality between wholesale and retail levels:

$ln\text{WP}_t = \alpha_1 + \sum_{i=1}^{n} a_i ln\text{RP}_{t-i} + \sum_{i=1}^{n} b_i ln\text{WP}_{t-i} + U_{1t}$

$ln\text{RP}_t = \alpha_2 + \sum_{i=1}^{n} c_i ln\text{RP}_{t-i} + \sum_{i=1}^{n} d_i ln\text{WP}_{t-i} + U_{2t}$ (equation 4.6)

(c) Testing causality between farm and retail levels:

$ln\text{FP}_t = \alpha_1 + \sum_{i=1}^{n} a_i ln\text{RP}_{t-i} + \sum_{i=1}^{n} b_i ln\text{FP}_{t-i} + U_{1t}$

$ln\text{RP}_t = \alpha_2 + \sum_{i=1}^{n} c_i ln\text{RP}_{t-i} + \sum_{i=1}^{n} d_i ln\text{FP}_{t-i} + U_{2t}$ (equation 4.7)

where; *ln* is the natural logarithm of each respective price series

FP$_t$ is the farm price at time (t)

WP$_t$ is the wholesale price at time (t)

RP$_t$ is the retail price at time (t)

FP$_{t-i}$ is lagged farm gate price

WP$_{t-i}$ is lagged wholesale price

RP$_{t-i}$ is lagged retail price

n is the upper limit set at the optimal lag length

a_i, b_i, c_i, and d_i are coefficients to be estimated using the ordinary Least squares method and α_1 and α_2 are intercepts

U_{1t} and U_{2t} are error terms that are assumed uncorrelated and white noise

The inference in the first mathematical statement of equation 4.5 is that current farm prices are dependent on past farm prices and past and present wholesale prices.

Likewise, the second mathematical statement postulates that current wholesale prices are dependent on past farm prices and past and present wholesale prices.

The inference in the first mathematical statement of equation 4.6 is that current wholesale prices are dependent on past wholesale prices and past and present retail prices.

Likewise, the second mathematical statement postulates that current retail prices are dependent on past wholesale prices and past and present retail prices.

The inference in the first mathematical statement of equation 4.7 is that current farm gate prices are dependent on past farm prices and past and present retail prices.

Likewise, the second mathematical statement postulates that current retail prices are dependent on past farm gate prices and past and present retail prices.

In each of the cases (a), (b) and (c), four causality relationships were tested by placing the appropriate restrictions on each model. P-values and F-tests were used to confirm statistical significance of the causality relationships.

For instance, in case (a) the following were the causality relationships tested between farm gate and wholesale prices;

(i) A unidirectional causality from wholesale to farm gate levels would be concluded if;

$\sum_{i=1}^{n} a_i \neq 0$ and $\sum_{i=1}^{n} d_i = 0$

(ii) A unidirectional causality from farm gate to wholesale levels would be concluded if,

$\sum_{i=1}^{n} a_i = 0$ and $\sum_{i=1}^{n} d_i \neq 0$

(iii) An absence of a causal relationship between the variables that is independence would be concluded if both

$\sum_{i=1}^{n} a_i = 0$ and $\sum_{i=1}^{n} d_i = 0$

This would imply that both sets of the lagged exogenous variables were not statistically different from zero.

(iv) a bilateral causality or feedback would exist if both

$\sum_{i=1}^{n} a_i \neq 0$ and $\sum_{i=1}^{n} d_i \neq 0$

This would imply that both sets of the lagged exogenous variables were, as a group, statistically significantly different from zero.

In formulating the above sets of VAR models, the VAR Lag Order Selection Criteria (VLOSC) was used to determine the optimal lag length. The VLOSC applies several measures for indicating the goodness of fit of alternative models. These measures include the Schwarz Information Criterion (SIC), the Akaike Information Criterion (AIC), sequential modified LR test statistic, Final Prediction Error (FPE), and Hannan-Quinn Information Criterion (HQIC).

4.3.5 Analysing price asymmetry

Price asymmetry was tested at two stages which are; (a) between farm gate and wholesale levels, and (b) between farm gate and retail levels in accordance with the Granger Causality test findings. Two alternative approaches, the Houck (1977) procedure and the Error Correction model (ECM) were employed in step with the cointegration test findings.

According to Moghaddasi (2009) the Houck approach is not consistent with cointegration between price series and when estimated without regard to the time series nature of the data used, spurious correlation can arise if the prices are non-stationary. Therefore, the Houck procedure of analysing price asymmetry can only be used when analysing price series that are not cointegrated. Hence, the Johansen cointegration tests were performed to guide the decision on whether to employ an ECM or the Houck procedure between each respective marketing level. The null hypotheses of the absence of a cointegration relationship (None) and presence of one cointegration relationship (at most one) between each respective series were tested. According to the SIC, the cointegration tests between farm prices and retail prices assume a linear deterministic trend in the series, and an intercept and trend in the cointegration models. On the other hand, the cointegration tests between farm prices and wholesale prices assume no linear deterministic trend in the series, no intercept and no trend in the cointegration models.

(a) Farm-Wholesale Price transmission

In order to examine whether changes in prices at the farm level are transmitted symmetrically to the wholesale level, the Houck (1977) procedure was used. The Houck procedure commenced with segmenting changes in prices at the point of price determination (FP) into decreases and increases. The following data was computed from the series of FP and WP;

Increase in Farm price $(iFP_t) = FP_t - FP_{t-1}$, when $FP_t > FP_{t-1}$

$$= 0, \text{ otherwise}$$

Decrease in Farm Price $(dFP_t) = FP_t - FP_{t-1}$, when $FP_t < FP_{t-1}$

$$= 0, \text{ otherwise}$$

Change in wholesale price $(\Delta WP_t) = WP_t - WP_{t-1}$

Once the above information was computed the Houck procedure required that equation 4.8 be estimated in first differences using OLS;

$$\Delta WP_t = a_0 + a_1 \, iFP_t + a_2 dFP_t \qquad\qquad \text{(equation 4.8)}$$

Given the relationship portrayed in equation 4.8, asymmetry or non-reversibility will occur in ΔWP_t if the coefficient for a price increase is statistically different from that of a price decrease, i.e. if $a_l \neq a_2$. Testing for the statistical differences between a_1 and a_2 was done using the t-test, which required the formulation of the following hypothesis;

$H_0 : a_1 = a_2$

$H_1 : a_1 \neq a_2$

The decision rule rejects the null hypothesis if the calculated t-value exceeds the critical t- value. Rejecting the null hypothesis means there is indeed price asymmetry between the two marketing chain levels in question.

The calculated t- value $= \dfrac{a1 - a2}{\sqrt{Var(a1) + Var(a2) - 2Cov(a1,a2)}}$, and the two tailed test follows a t-distribution with *n-k* degrees of freedom where *n*= number of observations and *k* = number of parameters estimated (Guvheya *et al.*, 1998).

(b) Farm-Retail Price transmission

In order to ascertain whether retailers adjust to farm price increases the same way they do to decreases, an Error Correction Model (ECM) was used. The ECM specification and estimation was done in accordance with the Engle and Granger (1987) two-step procedure in combination with the error correction term splitting concept and ECM presentation applied in Moghaddasi (2009).

As reviewed in Vavra and Goodwin (2005), the first step in estimating an error correction model according to Engle and Granger (1987) approach was to estimate the static cointegration regression using OLS. In this light, the cointegration regression equation 4.9 was set up and estimated.

$$ln\text{RP}_t = \alpha + \beta\, ln\text{FP}_t + \mu_t \qquad\qquad \text{(equation 4.9)}$$

where; $ln\text{RP}_t$ is the natural logarithm of retail price in time (t)

   $ln\text{RP}_t$ is the natural logarithm of farm price in time (t)

   α, β are coefficients

   μ_t represents the error term

The ADF test was applied to the estimated residuals under the null hypothesis of no cointegration between farm prices and retail prices. The null hypothesis would be rejected if the residuals were found to be $I(0)$ implying that the two price series are cointegrated. According to Vavra and Goodwin (2005), variables are cointegrated if they share a common unit root and the sequence of stochastic shocks is common to both. Price series may be non-stationary, yet having a linear combination between them that is stationary. If such a cointegration, relationship exists then it follows that the extent by which the series diverge from each other will have stationary characteristics and will reflect only the disequilibrium. Cointegration also entails that the prices though in the short run may drift apart, they move closely together in the long run.

After establishing the long run relationship between farm and retail prices with the aid of equation 4.9, the Error Correction Model (ECM) specified in equation 4.10, was estimated using OLS.

$$\Delta lnRP_t = \alpha_1 + \sum_{i=1}^{5} \beta_i \Delta \operatorname{Ln}RP_{t-i} + \sum_{j=0}^{5} \emptyset_j \Delta lnFP_{t-j} + \alpha_2^+ \operatorname{ECT}_{t-1}^+ + \alpha_2^- \operatorname{ECT}_{t-1}^- + \in_t$$

$$\text{(equation 4.10)}$$

where; $\Delta lnRP_t$ = first differenced lnRP in period (t)

$\sum_{i=1}^{5} \beta_i \Delta \operatorname{Ln}RP_{t-i}$ = the 1st, 2nd...5th lagged first-differenced values of lnRP

$\sum_{j=0}^{5} \emptyset_j \Delta lnFP_{t-j}$= the 1st, 2nd...5th lagged first-differenced values of lnFP as well as its value in period (t)

$\operatorname{ECT}_{t-1}^+$= positive error correction terms lagged by one period

$\operatorname{ECT}_{t-1}^-$= negative error correction terms lagged by one period

$\alpha_1, \beta_i, \emptyset_j, \alpha_2^+, \alpha_2^-$ are estimated coefficients

In equation 4.10, the error correction terms measure deviations from the long run equilibrium between farm level and retail level prices. Vavra and Goodwin (2005) reveal that including the error correction terms allows the estimated price to respond to the changes in the explanatory price but also correct any deviations from the long run equilibrium that may be left over from previous periods. The segmented positive and negative error correction terms make the test for asymmetric price transmission possible.

4.4 Conclusion

This chapter has covered the description of study area and methodology applied to this study. The next chapter will present both the descriptive and empirical results of the study.

CHAPTER 5: QUANTITATIVE ANALYSIS AND PRESENTATION OF RESULTS

5.1 Introduction

This chapter presents the results of the study. Analysis was based on 50 observations on farm gate, wholesale (JFPM) and retail prices of Limpopo Province's tomatoes. The data was collected on five day weekly intervals for the period from 23 May 2012 to 31 July 2012. The chapter is structured as follows; in the first section, the results of the marketing margins are presented. The succeeding sections present results of the unit root tests, the lag order selection criteria, the Granger causality tests and the tests of price asymmetry.

5.2 Marketing Margins

Prices of the tomatoes varied across the marketing chain over time. For the ten week period the highest weekly average farm gate price was R1.85/kg, while the lowest was R1/kg and the average farm gate price for the whole period was R1.37/kg. The highest wholesale price was R5.45/kg; while the lowest was R3.10/kg and the whole period average was R4.73/kg. The highest retail price was R9.60/kg, while the lowest was R8.79/kg and the average was R9.20/kg.

Table 5.1 shows the marketing margin structure of Limpopo Province's tomato marketing chain on five day weekly basis from 23 May 2012 to 31 July 2012.

Table 5.1 Five day weekly Marketing margins for Limpopo Province's tomato market chain

| Week | Rands/ kg | | | | | | % | |
	FP	WP	RP	F-to-W GMM	W-to-R GMM	F-to-R GMM	Total GMM	Producer GMM
1	1.33	4.17	8.79	2.84	4.61	7.45	84.84	15.16
2	1.34	4.93	9.28	3.60	4.34	7.94	85.58	14.42
3	1.85	4.80	9.37	2.95	4.57	7.52	80.27	19.73
4	1.76	5.23	8.95	3.48	3.71	7.19	80.36	19.64
5	1.14	4.42	9.08	3.28	4.66	7.94	87.44	12.56
6	1.00	3.10	9.60	2.10	6.50	8.60	89.58	10.42
7	1.46	5.45	9.49	3.98	4.04	8.03	84.56	15.44
8	1.29	5.19	9.15	3.90	3.97	7.86	85.94	14.06
9	1.18	4.98	9.09	3.81	4.11	7.92	87.07	12.93
10	1.36	5.02	9.20	3.66	4.18	7.83	85.19	14.81
average	1.37	4.73	9.20	3.36	4.47	7.83	85.08	14.92

The relationship between farm gate, wholesale and retail price data in table 5.1 can also be illustrated by means of figure 5.1.
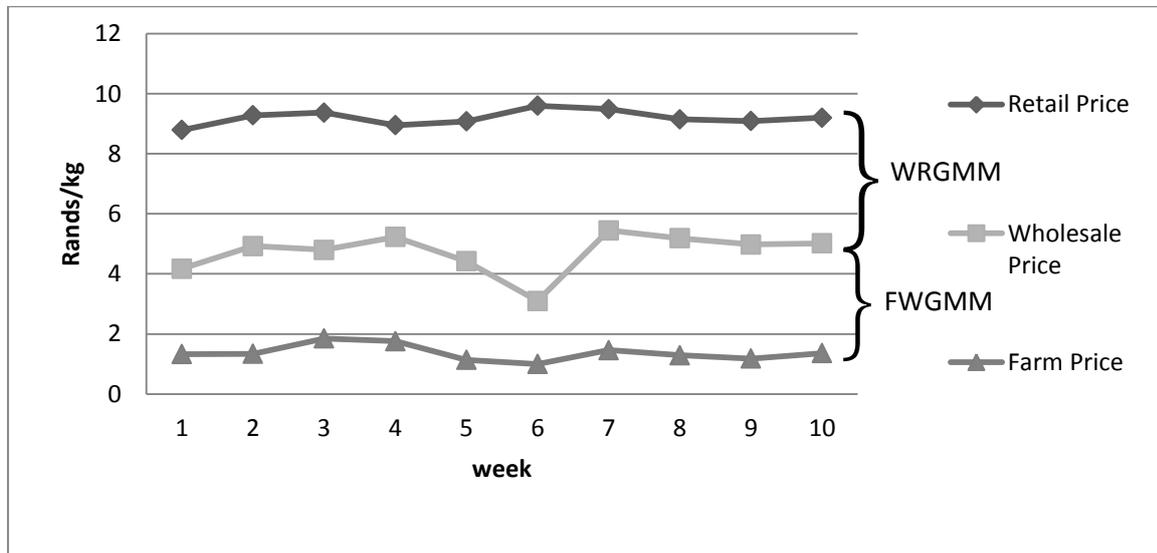
Figure 5.1 Five day weekly average margin structure of Limpopo Province's tomato market chain

Figure 5.1 shows the relationship between weekly average prices of tomato at three levels in absolute terms. The vertical distance between each price prices reflect the margins between the respective price levels at each point in time.

The average farm-to-wholesale gross marketing margin (FWGMM) of R3.36 and the average wholesale-to-retail gross marketing margin (WRGMM) of R4.47 in sum give us the average farm-to-retail gross marketing margin (FRGMM) of R7.83. With the average retail price of R9.20, it follows that consumers typically had to part with R9.20 for every kilogram of tomato they purchased from retailers. However, comparing the FRGMM of R7.83 with the average retail price we can conclude that the total gross marketing margins constituted about 85.1% of the consumer's Rand. With such a high marketing margin, the common hypothesis that the farmers' portion of the consumer's Rand is low holds true. During the period of analysis, tomato farmers were getting only 14.9% from every Rand spent by consumers on tomatoes at retail level.

5.3 Unit root tests

The information on margins, given in the previous section, prompts the need to undertake further explorations on vertical price linkages amongst different levels in

the marketing chain of tomatoes in Limpopo Province. The statistical properties of the price series are analysed before carrying out causality tests and thereafter tests for price asymmetry. Table 5.2 presents an abstract of results of the unit root tests performed on *ln*FP, *ln*WP, and *ln*RP according to the Augmented Dickey-Fuller (ADF) criteria.

Table 5.2: Augmented Dickey Fuller Test Results on *ln*FP, *ln*WP, *ln*RP in levels

Null Hypotheses: each of *ln*FP, *ln*WP, and *ln*RP contain a unit root				
*ln*FP	ADF test statistic	t-Statistic -2.083252	Prob. 0.5419	Lag Length: 0 (Automatic - based on
	Test Critical Values	1% level 5% level 10% level	-4.156734 -3.504330 -3.181826	SIC, maxlag=5) DW stat: 1.799676
*ln*WP	ADF test statistic	t-Statistic -0.073823	Prob 0.6531	Lag length: 1 (Automatic - based on
	Test Critical Values	1% level 5% level 10% level	-2.614029 -1.947816 -1.612492	SIC, maxlag=5) DW stat: 2.089489
*ln*RP	ADF test statistic	t-Statistic 0.126524	Prob 0.7180	Lag length: 0 (Automatic - based on
	Test Critical Values	1% level 5% level 10% level	-2.613010 -1.947665 -1.612573	SIC, maxlag=5) DW stat: 2.548604

The results in Table 5.2 shows that ADF test-statistic values of the three price series are greater than the MacKinnon critical values for rejecting the hypotheses of a unit root. As a result, we cannot reject the null hypothesis of a unit root at 1%, 5% and 10% levels of significance. This regression result can be trusted since the Durbin-Watson statistics are all significant enough to reject the presence of serial correlation in each of the three series. With the statistical evidence generated, we can therefore conclude that the farm gate, wholesale and retail price series of Limpopo produced tomatoes for the period of analysis is non-stationary.

Vavra and Goodwin (2005) noted that most economic time series being non-stationary in nature need some transformation through differencing or de-trending,

otherwise the regression will be spurious. Spurious regressions occur when the mean, variance and covariance of a time series vary with time. The classic results of a usual regression cannot be legitimate if non-stationary series of data is used for analysis.

As such, first differences were taken on each of the three series *ln*FP, *ln*WP, *ln*RP to come up with a differenced set of data, D*ln*FP, D*ln*WP, and D*ln*RP that is unit root free. The summary of the ADF test on the first differenced series are shown in Table5.3.

Table 5.3: Augmented Dickey Fuller Test on D*ln*FP, D*ln*WP, and D*ln*RP (first differences)

Null Hypotheses: each of D*ln*FP, D*ln*WP and D*ln*RP contain a unit root			
D*ln*FP	ADF test statistic	t-Statistic Prob -6.644587 0.0000	Lag length: 0 (Automatic - based on SIC, maxlag=3)
	Test Critical Values	1% level -4.161144 5% level -3.506374 10% level -3.183002	DW stat: 2.004682
D*ln*WP	ADF test statistic	t-Statistic Prob -11.33005 0.0000	Lag length: 0 (Automatic - based on SIC, maxlag=5)
	Test Critical Values	1% level -4.161144 5% level -3.506374 10% level -3.183002	DW stat: 2.097217
D*ln*RP	ADF test statistic	t-Statistic Prob -9.150489 0.0000	Lag length: : 0 (Automatic - based on SIC, maxlag=5)
	Test Critical Values	1% level -2.614029 5% level -1.947816 10% level -1.612492	DW stat: 2.030275

Table 5.3 shows that ADF test-statistic values of the three differenced price series are less than the MacKinnon critical values for rejecting the hypotheses of a unit root. As a result, the null hypothesis of a unit root in first differences of *ln*FP, *ln*WP and *ln*RP can be rejected at 1%, 5% and 10% levels of significance. Again, the regression result can be trusted since it passed the Durbin-Watson test. It can therefore be concluded with 99% confidence that the DFP, DWP and DRP series of

Limpopo produced tomatoes for the period of analysis are stationary since there is enough statistical evidence to support this. The implication of the ADF tests results is that the series generating the three price variables are all integrated of order one, that is, I(1).

5.4 Lag order selection criteria

The next step was to carry out the lag-order-selection criteria for correct specification of the VAR model to use in Granger Causality tests. Results showing the optimal lag lengths to use in the causality tests are summarized in Table 5.4. For the sample with 50 observations collected from 5/23/2012 to 7/31/2012, *In*FP and *In*RP were the endogenous variables, while the constant C was the only exogenous variable.

Table 5.4: Vector Auto Regressive lag order Selection Criteria (*In*FP and *In*RP)

Lag	LR	FPE	AIC	SC	HQ
0	NA	6.40e-05	-3.980930	-3.900634	-3.950997
1	70.25371	1.44e-05	-5.475860	-5.234972*	-5.386059*
2	6.503296	1.46e-05	-5.460664	-5.059184	-5.310997
3	4.282047	1.56e-05	-5.395572	-4.833499	-5.186037
4	9.614758*	1.44e-05	-5.484871	-4.762206	-5.215469
5	7.539553	1.39e-05*	-5.528845*	-4.645588	-5.199575

In Table 5.4, the asterisk (*) indicates lag order selected by each criterion, LR is the sequential modified LR test statistic (each tested at 5% level), FPE is Final Prediction Error, AIC is the Akaike Information Criterion, SC is the Schwarz Information Criterion and HQ stands for Hannan-Quinn Information Criterion. The VAR lag order selection criteria results summarized in the table show that AIC and FPE chose 5 lags, SC and HQ 1 lag and only LR chose 4 lags. However, retailers indicated that they in most cases alter their tomato prices on weekly basis. It is therefore reasonable to accept the AIC and FPE choices given the available knowledge of the tomato retail markets in Limpopo Province. As a result, five lags were used as the optimal lag length for testing Granger Causality and cointegration relationships between farm gate prices and retail prices.

The same procedure was done to determine the optimal lag length between farm gate and wholesale prices and results are shown in Table 5.5. For the sample with 50 observations collected from 5/23/2012 to 7/31/2012, *In*FP and *In*WP were the endogenous variables, while the constant C was the only exogenous variable.

Table 5.5: Vector Auto Regressive lag order Selection Criteria (*In*FP and *In*WP)

Lag	LR	FPE	AIC	SC	HQ
0	NA	0.001598	-0.763229	-0.682933	-0.733296
1	59.44108*	0.000464*	-2.000715*	-1.759827*	-1.910915*
2	3.811524	0.000504	-1.918226	-1.516745	-1.768558
3	2.279414	0.000569	-1.800433	-1.238360	-1.590898
4	7.039860	0.000563	-1.818206	-1.095541	-1.548804
5	4.482782	0.000594	-1.772275	-0.889018	-1.443006

Table 5.5 shows that the optimal lag length between the farm and wholesale is one. In the same way the VAR Lag Order Selection Criteria results for wholesale and retail prices are shown in Table 5.6.

Table 5.6: Vector Auto Regressive lag order Selection Criteria (*In*WP and *In*RP)

Lag	LR	FPE	AIC	SC	HQ
0	NA	3.93e-05	-4.467427	-4.387131	-4.437494
1	26.85320*	2.48e-05*	-4.929011*	-4.688123*	-4.839211*
2	7.009408	2.49e-05	-4.926469	-4.524988	-4.776801
3	2.730931	2.78e-05	-4.820558	-4.258485	-4.611023
4	3.816023	3.00e-05	-4.748781	-4.026116	-4.479378
5	7.354435	2.92e-05	-4.787310	-3.904052	-4.458040

Table 5.6 shows that the optimal lag length between the wholesale and retail is one. *In*WP and *In*RP were the endogenous variables.

5.5 Granger Causality tests

To run regression analysis, it is necessary that causality tests to determine which of the series in question is dependent on the other be conducted first. The results for the pair wise Granger causality test on the series *In*FP, *In*WP and *In*RP are presented in Table 5.7.

Table 5.7 Results of Pair wise Granger Causality Tests for *ln*FP, *ln*WP, and *ln*RP

Null Hypothesis	Lags	Obs.	F-stat.	Prob.	Decision
*ln*WP does not Granger Cause *ln*FP	1	49	9.1E-06	0.9976	Do not reject
*ln*FP does not Granger Cause *ln*WP			8.19633	0.0063	Reject
*ln*WP does not Granger Cause *ln*RP	1	49	0.77784	0.3824	Do not reject
*ln*RP does not Granger Cause *ln*WP			0.28772	0.5943	Do not reject
*ln*FP does not Granger Cause *ln*RP	5	45	3.93156	0.0064	Reject
*ln*RP does not Granger Cause *ln*FP			1.12593	0.3654	Do not reject

5.5.1 Price causality between farm and wholesale

Table 5.7 shows that the p-value (0.0063) is significant at 1% level. As a result the hypothesis that *ln*FP does not cause *ln*WP can be rejected. In support of this assertion, the p-value (0.9976) on the other hand is insignificant which means we cannot reject the hypothesis that *ln*WP does not cause *ln*FP. With such statistical evidence, it can be concluded that there exists a unidirectional causality from the farm level to the wholesale level. This implies that farm prices cause wholesale prices. A high industry concentration that is present at the farm level can be the reason for the direction of price flow from the farm (who has market power) to the wholesale (who use the commission system based on the prices set by farmers).

5.5.2 Price Causality between wholesale and retail

Table 5.7 also shows that both p- values (0.3824 and 0.5943) are insignificant at 5% level, as such we do not reject the null hypotheses of *ln*WP not Granger causing *ln*RP and *ln*RP not Granger causing *ln*WP. However, the F-statistic probabilities indicate a slight possibility of the hypothesis of *ln*WP not causing *ln*RP more likely to be rejected at a higher significance level. In this sense, it is more likely that wholesale prices may perhaps cause the retail prices than the opposite even though the chances are trivial. This weak causal relationship is represented by the dotted

line in Figure 5.2. The empirical evidence available at 5% level even so, still suggests that there is no extrapolative power between wholesale prices and retail prices. It therefore follows that an independent causal relationship exists between the wholesale and the retail levels. Possible explanations for such a causal relationship is the growing outsourcing behaviour of, and direct purchasing from the farms by some tomato retailers in the Limpopo Province. For instance during the exploratory phase of this study, it was established that some retailers such as Goseame consider NFPMs as a competitor than a supplier.

5.5.3 Price Causality between farm and retail

The p-value (0.0064) is significant at 1% level while p-value (0.3654) is insignificant at 1%, 5% and 10% levels. The hypothesis that *In*FP does not cause *In*RP can therefore be rejected while the one for *In*RP not causing *In*FP cannot. It can be concluded that prices stream unidirectional from the farm level to the retail level. In other words, farm gate prices have a predictive power on retail prices. The market structure of the tomato industry in Limpopo Province suggests a high concentration at the farm level than at the retail. Such can be the reason for the direction of price flow from the farm (who has more market power) to the retail level.

The causality relationships that exist amongst the three series are demonstrated in Figure 5.2. Arrows represent the direction of price flow, where solid and dotted lines symbolize a strong and a weak causal relationship respectively.
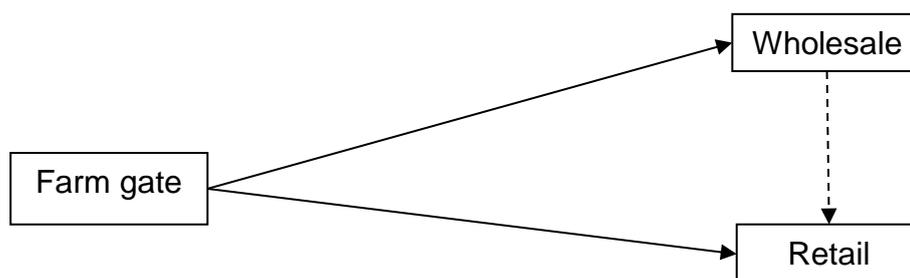

Figure 5.2: Points of price determination and direction of price causality

As shown in Figure 5.2 the farm gate plays a major role in the price formation process of tomato markets in Limpopo Province. As a result, the farm gate's current and past price information is useful in improving the forecasts of both the wholesale

and retail prices it causes. The figure also indicates that there is a weak causal relationship between the wholesale and retail level prices. The weak dependence of Limpopo retail prices on Johannesburg's wholesale prices can be attributed to the proximity of retailers to tomato farms than they are to the Johannesburg Market. As a result it is sensible that Johannesburg wholesale prices may be seldom useful in predicting tomato retail prices in Polokwane considering the increasing direct sourcing by Limpopo retailers from farmers.

5.6 Tests for price asymmetry

Since the point of price determination and direction of causality along the major marketing channel for tomato in Limpopo Province has been estimated, we can move on to test price asymmetry. The next section seeks to ascertain whether changes in prices at the farm level are transmitted symmetrically to the wholesale and retail stages in the marketing channel for tomato in Limpopo Province. The first step in achieving this end was to carry out the Johansen cointegration test whose results are presented in Table 5.8.

Table 5.8: Results of Johansen Cointegration test between price series

Between stages	Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 critical value	Prob [2]
*In*FP and *In*RP	None[1]	0.417086	28.72298	25.87211	0.0215
	At most 1	0.106921	4.975516	12.51798	0.5999
*In*FP and *In*WP	None	0.109106	5.563446	12.32090	0.4912
	At most 1	0.000375	0.017997	4.129906	0.9127
[1] denotes rejection of the hypothesis at 5% significance level					
[2] Mackinnon-Haug-Michelis (1999) p-values					
Trace test indicates *r* cointegrating model(s) at 5% significance level					

According to the results in Table 5.8, the hypothesis of no cointegration relationship existing between farm prices and retail prices is rejected. There is thus, a long run cointegration relationship existing between the two price series. This is informed by the trace test that fails to reject at most one cointegration model (CE) at 5% significance level. Because of this cointegration relationship, the Houck procedure cannot be used for analysing price asymmetry between these levels. Given the

statistical properties of the data, an ECM is the most appropriate approach applied to test price asymmetry between farm and retail levels.

5.6.1 Farm gate to wholesale price transmission

The trace statistic in Table 5.8 fails to reject at the 5% level, any of the hypotheses set for the Johansen test between farm gate prices and wholesale prices. This finding suggests that farm and wholesale price series are not cointegrated. Therefore, the Houck procedure can be used to analyse price transmission between these two levels. The procedure intends to find whether unit increases in farm gate price from period to period had a different absolute impact on wholesale prices than unit decreases. The results according to the Houck (1977) procedure are shown in table 5.9 where the dependent variable is ΔWP_t, the method used is least squares for a sample size of 50 observations.

Table 5.9: Houck procedure for Farm-Wholesale Price transmission

Variable	Coefficient	Std. Error	t-statistic	Prob.
Constant	0.010911	0.175601	0.062134	0.9507
iFP_t	0.929481	1.418683	0.655171	0.5156
dFP_t	0.890212	1.567608	0.567879	0.5729
Var (a_1) 2.012662		Var (a_2) 2.457396		Cov (a_1,a_2) -0.388695
Degrees of freedom 46		Calculated t-value (0.01714)		

For 46 degrees of freedom, the calculated t-value (0.01714) fails to exceed the critical t-value even up to 0.9863 significance level for a two-tailed test. Therefore, we cannot reject the null hypothesis that the coefficients for farm price increases and decreases are equal. It can therefore be concluded that the effect of increasing farm gate prices is statistically not different from that of decreasing prices. In simpler terms, price transmission from the farm level to the wholesale stage of Limpopo produced tomatoes is symmetric. If ever there could be a possibility of price asymmetry existing between these two levels, there is less than 2% confidence to support that claim. When price transmission is symmetric between marketing levels,

Guvheya *et al.* (1998) consider that as an indication of some level of market efficiency between the levels in question. This could be the case in the context of Limpopo Province's tomato markets considering the relationship that exists between farmers and the NFPMs in terms of price information dissemination. Under the commission system, it can be expected that whenever the producer price changes, the wholesale price would have to change more or less proportionately to and in the same direction as the producer price change.

5.6.2 Farm gate to retail price transmission

The ECM approach illustrated in von Cramon-Taubadel and Fahlbusch (1996) requires an application of the Engle and Granger two-step procedure in estimating error correction models. According to the approach, a cointegration regression relationship between *ln*FP and *ln*RP was estimated using OLS. Unit root tests were applied to the estimated residuals in order to test the null hypothesis of no cointegration between the *ln*FP and *ln*RP series. The results of the ADF test on the residuals are shown in table 5.10.

Table 5.10: Results of ADF unit root test on residuals of the Granger and Engel cointegration test of the relationship between *ln*FP and *ln*RP

H_0: Residuals have a unit root (no integration between FP and RP)	ADF test statistic	t-Statistic Prob -3.830863 0.0003	Lag length:0 (Automatic- based on SIC, max Lag=5)
	Test Critical Values	1% level -2.613010 5% level -1.947665 10% level -1.612573	DW stat: 2.057591

According to table 5.10 we reject the null hypothesis and accept that farm gate prices and retail prices are cointegrated since the residuals are *I* (0). This finding confirms the results of the Johansen cointegration test carried earlier that failed to reject at most one cointegration relationship between farm and retail prices. Accepting that a cointegration relationship exists between farm prices and retail prices means that model (4.9) (in section 4.3.5) describes the long run relationship between the two series.

The second step involves estimating the ECM by running model (4.10) (in section 4.3.5) with OLS and that gives the results shown in table 5.11.

Table 5.11: Empirical Results of the Error Correction Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant (α_1)	0.005415	0.006804	0.795845	0.4324
$\Delta ln\text{RP}_{t-1}$	0.036386	0.219423	0.165826	0.8694
$\Delta ln\text{RP}_{t-2}$	0.071384	0.193480	0.368947	0.7148
$\Delta ln\text{RP}_{t-3}$	0.292458	0.179287	1.631227	0.1133
$\Delta ln\text{RP}_{t-4}$	0.212064	0.165728	1.279590	0.2105
$\Delta ln\text{RP}_{t-5}$	0.137968	0.166174	0.830265	0.4129
$\Delta ln\text{FP}_{t}$	-0.034864	0.039986	-0.871903	0.3902
$\Delta ln\text{FP}_{t-1}$	-0.010371	0.036280	-0.285854	0.7770
$\Delta ln\text{FP}_{t-2}$	0.055103	0.033396	1.649987	0.1094
$\Delta ln\text{FP}_{t-3}$	0.068348	0.034386	1.987644	0.0560*
$\Delta ln\text{FP}_{t-4}$	0.030513	0.036056	0.846270	0.4041
$\Delta ln\text{FP}_{t-5}$	-0.119578	0.035030	-3.413587	0.0019***
ECT_{t-1}^{+}	-0.676644	0.276938	-2.443305	0.0207**
ECT_{t-1}^{-}	-0.415170	0.448446	-0.925797	0.3619
R-squared	0.580677			
Durbin Watson stat.	2.350648			
Note:	*significant at 10%, ** significant at 5%, *** significant at 1%			

The results in Table 5.11 provide empirical evidence of price asymmetry between the farm and the retail levels of the tomato marketing chain in Limpopo Province. The positive error correction term (ECT_{t-1}^{+}) is statistically significant at 5% level. On the contrary, the negative error correction term (ECT_{t-1}^{-}) is insignificant at 1%, 5% and 10% levels. This confirms that tomato retailers regard farm price increases a considerable threat to their profits than decreases and for that reason are ever ready to react more when farm gate prices increase. A comparison between magnitudes of the estimated coefficients of both ECTs reveals that positive error correction terms provoke appreciably greater change in retail prices than negative error correction terms. These results indicate asymmetric price transmission between the farm level and the retail level. A possible explanation of this asymmetry could be the profit maximizing behaviour of retailers who react faster to profit threatening situations than to price movements that favour them. Because of such inter-temporal profit

maximization mind-set, retailers are also reluctant to incur fixed price adjustments costs when there are price reductions at the farm level. As retailers evade price adjustment expenses, there will be a situation where consumers still spend more for a unit of tomatoes from the retailers whether farm gate prices have increased or decreased. This finding concurs with Jaffry (2005) who argued that if there is asymmetric price transmission, consumers may not benefit from price reductions which tend not to be fully passed on to them. Ben-Kaabia and Gil (2007), also confer that retailers usually benefit from any shock that affects supply or demand conditions regardless of whether it is positive or negative. Retailers react faster when their margins are squeezed than when they are stretched (Kirsten and Cutts, 2006).

5.7 Conclusion

This chapter has presented both the descriptive and empirical results of the study. The next chapter summarises the study, discusses the conclusions derived from the study and puts forward some recommendations for policy makers.

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

This study was aimed at establishing and analysing the nature of price transmission in tomato markets of Limpopo Province, South Africa. The objectives of the study were to give an overview of tomato production and marketing in Limpopo Province, estimate the point(s) of price determination and direction of causality along the marketing chain of tomato in Limpopo Province and to ascertain whether or not changes in prices at the point(s) of determination are transmitted symmetrically to other stages in the marketing chain for tomato in Limpopo Province. Both primary and secondary data on average daily tomato prices were collected at three levels that reflect the marketing chain of Limpopo produced tomatoes. Data collection was accomplished through surveys and document analysis. The concurrent gross marketing margin method was used for marketing margin analysis. In line with the statistical properties of the data, the Houck procedure and the ECM were applied in analysing price transmission between marketing levels.

The study attempted to fill the knowledge gap on the performance of Limpopo Province's tomato markets by examining vertical price linkages amongst successive marketing levels. The main findings herein are recapped below;

The gross marketing margins constitute about 85.1% of the consumer's Rand. This reflects a huge gap between what farmers receive from retailers and what retailers receive from consumers. Farmers are getting less than 15% of each Rand spent by the consumer while the rest of consumer's expenditure on tomatoes is taken up by the marketing function.

The VAR lag order selection criteria showed that the optimal lag lengths between the levels; farm gate and wholesale, farm gate and retail, wholesale and retail are 1, 5 and 1 respectively. Since the reaction to a price change at the point of determination does not reflect instantaneously at the other levels in a marketing chain, these optimal lag lengths indicate that wholesale prices are faster in adjusting to farm gate price changes than do retail prices.

The results of the pair-wise Granger Causality tests suggested a unidirectional causality from farm to wholesale and also from farm to retail. However, a weak causal relationship was found between wholesale and retail levels. It therefore follows that tomato prices are determined at the farm gate in Limpopo Province.

The Houck approach found no evidence of asymmetric price transmission between farm gate and wholesale levels. This implies that prices are transmitted symmetrically between these two levels. On the other hand, the Error Correction Model found asymmetry in price transmission between farm gate and retail levels. This entails that retailers react quicker to farm gate price increases than to decreases.

6.2 Conclusions

Based on the preceding summary of findings, the following conclusions are drawn;

There exists a large gap between what consumers pay for each unit of tomatoes purchased from retailers, and the amount farmers receive for the same quantity from retailers in Limpopo Province. It therefore follows that the producers' portion of the consumers' Rand is low since according to the findings, a major part of tomato retail prices constitutes total gross marketing margins.

Generally, the tomato industry in Limpopo Province is highly concentrated. For instance, the production subsector consist a number of small to medium scale farmers who co-exist with ZZ2, the largest privately owned tomato producer in the Southern hemisphere. Such a dualistic production and marketing set up inevitably gives the largest farmer dominion and control over the greater market share owing to its economies of scale advantage. Consequently, the dominant farmer acts as the price leader.

An important conclusion drawn from the causal relationships between the farm gate, wholesale and retail prices is that the farm level is key to tomato price determination in Limpopo Province. It therefore means that current and past information on farm gate prices is useful in improving estimations of both wholesale and retail prices it causes. According to Guvheya *et al.* (1998), information on causality shows the direction of price flow between levels and thus helps in the identification of points of

price determination along the marketing chain. In the light of this statement, it can be concluded that tomato prices in Limpopo Province are determined at the farm level.

Price transmission is more efficient between the farm gate and the wholesale levels than between the farm gate and retail levels. Due to the fact that retailers' profits are threatened whenever farm prices increase than when they decrease, they tend to make quicker positive price adjustments in response to farm price increases than negative price adjustments when there are price reductions at farm level. As a result, retail consumers do not fully benefit from tomato price reductions at the farm level since such shocks are not fully transmitted to them.

6.3 Recommendations

The recommendations discussed in this section are based on the findings of the study.

The study found that tomato prices in the Limpopo Province are determined at the farm gate. This means that ZZ2 has a significant influence in the tomato price formation process in Limpopo Province owing to its dominance with relation to market share. It is recommended that the government intensifies its small scale farmers support programs so as to encourage competition at the farm level. This will ensure that in the future, prices will not have to be determined by only one major producer. A scenario where only one farmer dominates a market potentially leads to situation where all price movements are influenced by this single player while the other farmers are simply price takers regardless of their cost structures.

In order to counteract ZZ2's dominance, small scale farmers are also encouraged to combine their efforts, pool their resources together and form co-operatives of manageable sizes and membership yet large enough to compete effectively with ZZ2. However it may need several years for these cooperatives to compete with ZZ2 at an equal scale considering the experience and reputation that this dominating farmer has. Nevertheless, it cannot be ignored that such cooperatives if properly managed can also help small scale farmers strengthen their bargaining power, improve their access to competitive credit and markets as well as improving their incomes.

The study also established that price transmission is more efficient between the farm and wholesale levels than between the farm and the retail levels. Such differences in efficiency of price transmission could be as a result of dissimilarity in the way marketing information is transmitted amongst market players. For instance the major wholesalers of tomato in South Africa, the NFPMs are very transparent in as far as price information is concerned. Such price information symmetry allows every stakeholder to be aware of the market prices of tomato from time to time which leaves no room for artificial price manipulation by the wholesalers. It is recommended that a similar price broadcasting system be adopted by retailers so that their price information is made public from time to time to facilitate the price monitoring exercise.

It is also suggested that the government intervenes through monitoring the pricing mechanism in the Limpopo tomato retail market to address the asymmetric price transmission detected between the farm and retail levels. The study found that retailers are quicker to fully pass on farm gate price increases than decreases. This leads to a situation where consumers are not fully benefiting from price reductions by farmers. If the ultimate goal therefore, is to maximize society welfare, measures to improve the functioning and stability of tomato markets need to be put into effect. The government is advised to intensify price monitoring especially at the retail level so that whenever prices fall at the farm level, consumers may also be able to benefit fully from such price movements in the same way they suffer when price increases are passed fully onto them.

6.4   Area for further research

The study established that the gross marketing margins of tomato in Limpopo Province are high. However the source of such huge marketing margins has not been ascertained between marketing costs and retailers' profits. This study only managed to alert on the existence of high marketing margins that constitute the major portion of the consumer's Rand. It is therefore recommended that further research be undertaken to establish whether the retailers' profits are unfairly high or perhaps whether the marketing margins are as a result of high marketing costs. Such a complementary study will assist in identifying the actual basis of the high marketing margins so that corrective policy measures can be directed appropriately.

When the actual tomato handling costs that farm-to-retail intermediaries experience daily are established, it will be possible to determine the net marketing margins. Knowledge of net marketing margins will be useful in determining whether the income gap between farmers and retailers is justifiable. Otherwise, the retailers' profits are simply abnormally high.

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ANNEX 1

TYPES OF PRICE ASYMMETRY

(a) Positive and Negative Price Asymmetry
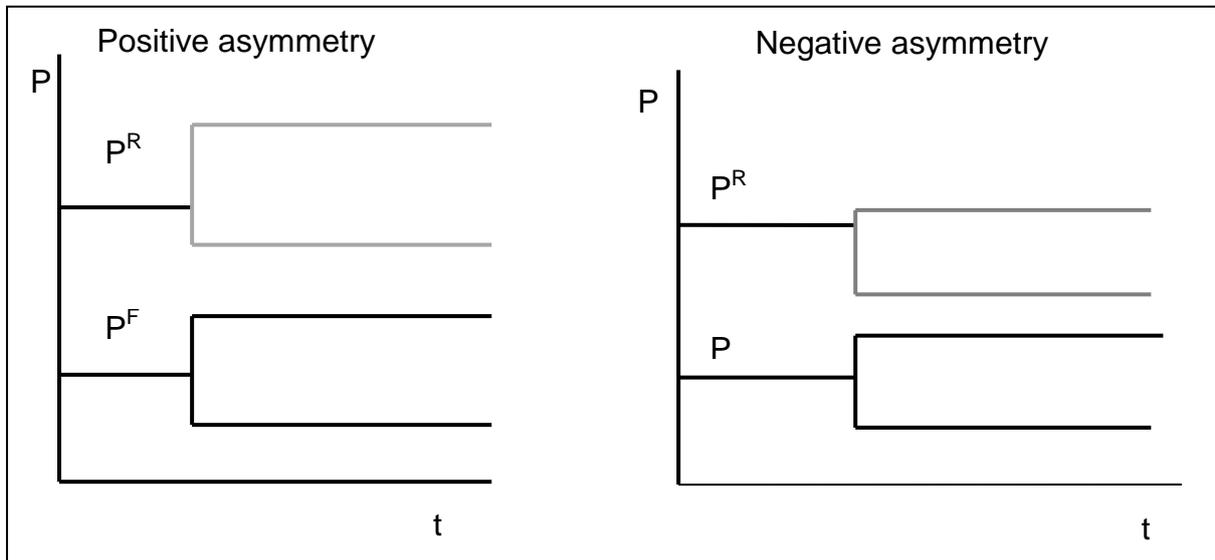
Source: Karantininis et al. (2011)

(b) Asymmetry in magnitude
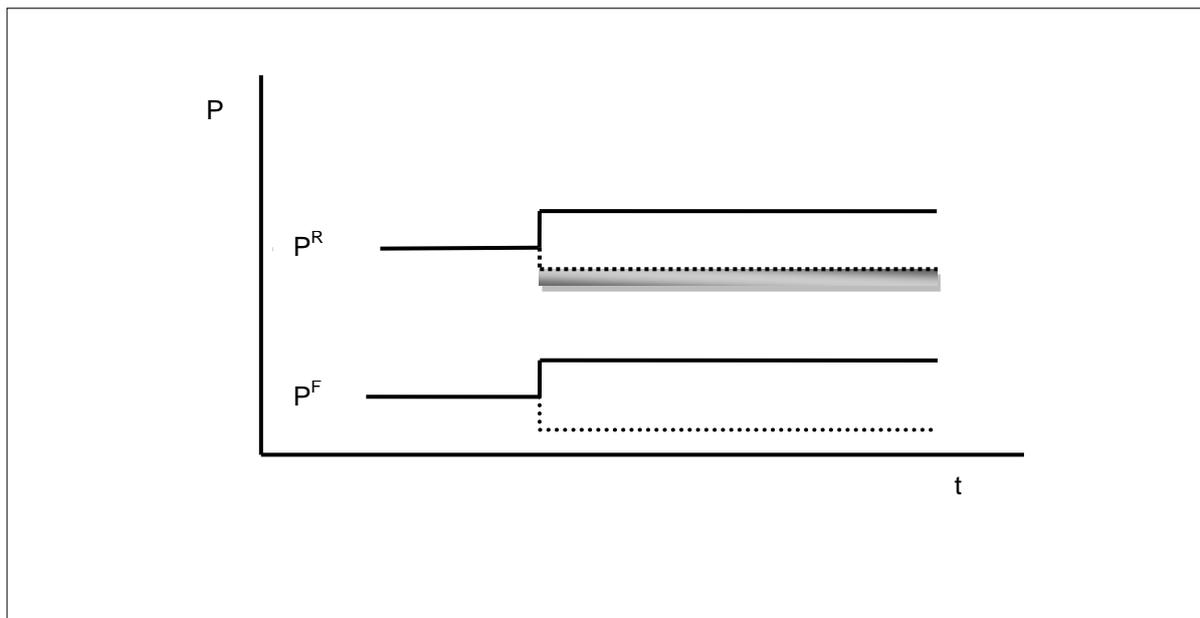
Source: Meyer & Cramon-Taubadel (2000)

(c) Asymmetry in speed
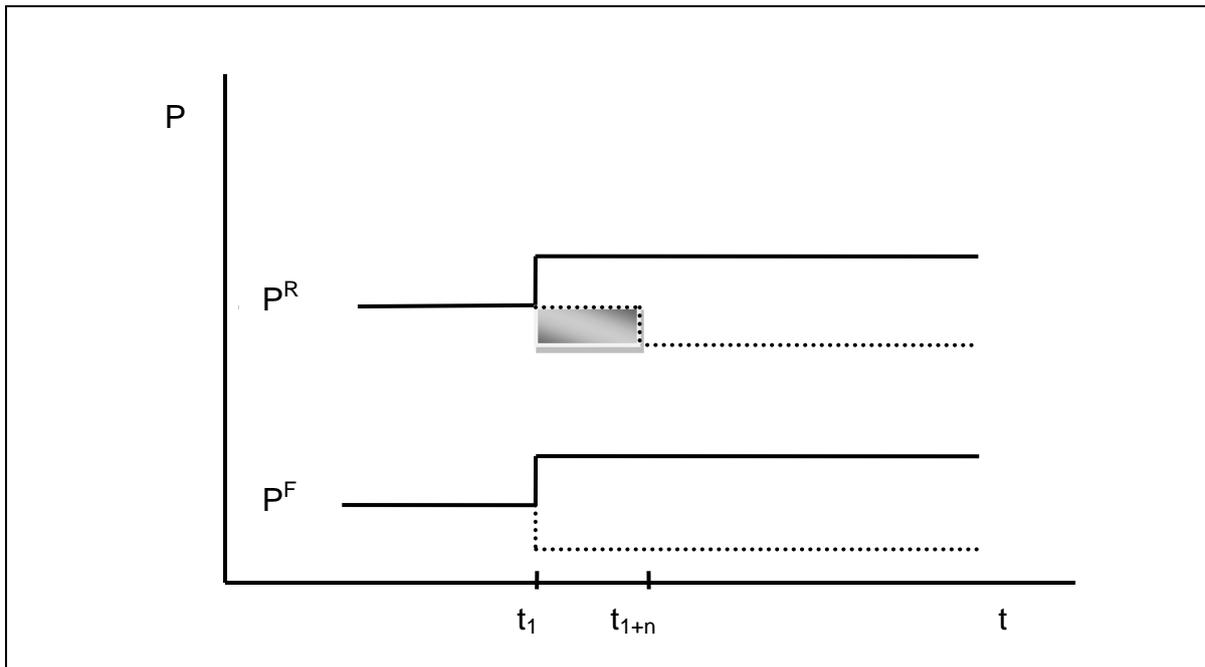
Source: Meyer & Cramon-Taubadel (2000)

(d) Asymmetry in both speed and magnitude

Source: Meyer & Cramon-Taubadel (2000)

76
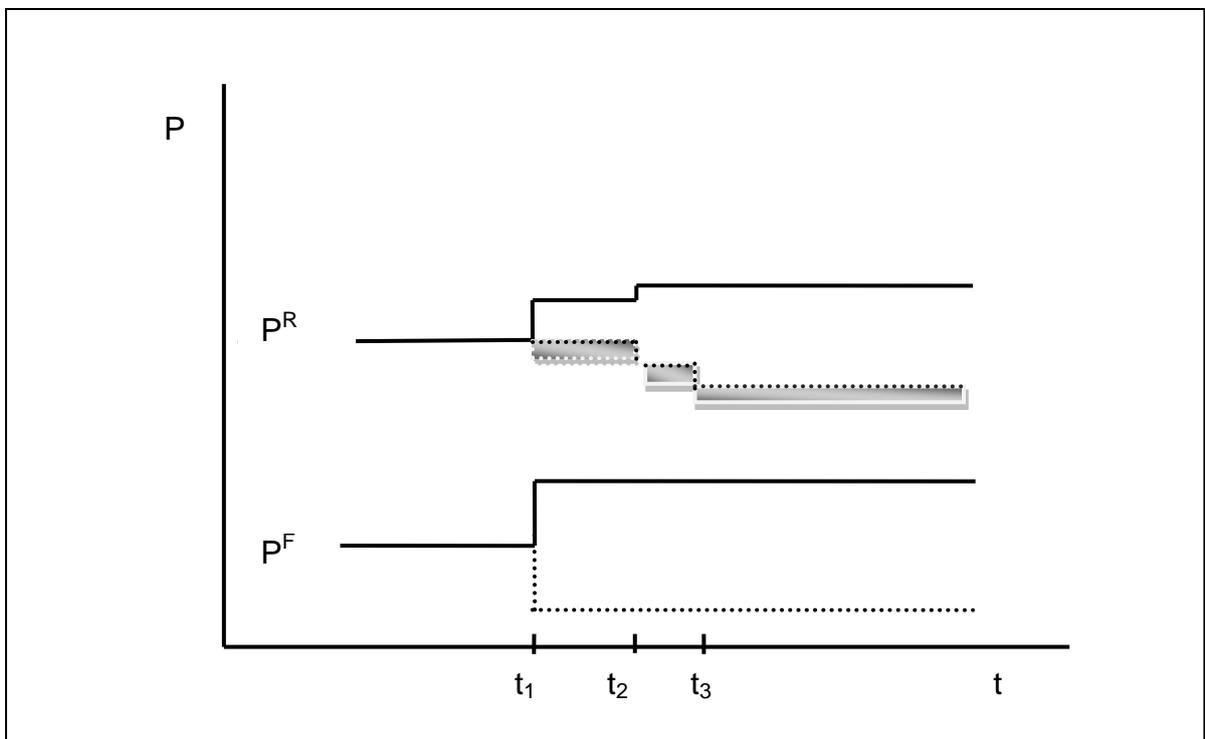
RESEARCH INTERVIEW GUIDE ON TOMATO MARKETING PROCEDURES IN LIMPOPO PROVINCE AND THE TOMATO PRICE OBSERVATION SHEET

TOPIC: PRICE TRANSMISSION IN TOMATO MARKETS OF LIMPOPO PROVINCE, SOUTH AFRICA

Hello, my name is Kudzai Mandizvidza. I am a Master of Science in Agriculture (Agricultural Economics) student at the University of Limpopo, Turfloop campus and I am conducting a research on the price transmission in tomato markets of the Limpopo Province, South Africa. I would really appreciate if you could spend the next 20 minutes responding to the questions. You are also free to decide not to answer any question that you are not comfortable with. I am also available to provide answers to any question you may have regarding this study. The information we will share in this interview will be used to bring together an academic mini dissertation report and nothing else. Your assistance in this regard is greatly appreciated.

Interview date   _____

Interviewer's name   _____

Interviewee's name   _____

Location of interview   _____

Initial time   _____

Ending time   _____

Important questions for an exploratory interview with the chairman of Limpopo Tomato Growers Association on marketing procedures

1. When was the Limpopo Tomato Growers Association (LTGA) established?

2. How many tomato farmers make up the total membership and what is their composition in terms of scale of operations? How has the membership changed with time since establishment?

3. Is the major tomato producer in the province a member of LTGA and if not why?

4. What are the factors that led to the birth of this commodity group (LTGA)? In other words what was the main aim of establishing LTGA?

5. How far has LTGA gone in achieving its objectives particularly those related to marketing?

6. What are the marketing strategies employed by the LTGA on behalf of its members? (Information required include, amounts sold at which times in season, prices, place of sale, dates of sale, buyers, methods of payment, any promotions, any value addition activities, marketing channels?)

7. What are the major challenges you face as Limpopo tomato farmers particularly in marketing your tomatoes? (follow up will be made on changes in number of buyers/sellers from season to season, prices received versus costs incurred, payment problems, transportation)

8. Can you please describe your relationship with other institutions (please specify the type of any technical assistance received, the institutions that provide it and the conditions under which assistance is provided)

Thank you!

Important questions for an exploratory interview with the tomato retailers around Polokwane on their marketing procedures

1. Can you please describe your tomato procurement strategies (in other words, how do you obtain stock?)
2. Do you have any major suppliers in the province and from where else does your product come from?
3. Are tomatoes delivered to you or do you go get them from the farms or fresh produce markets?
4. Can you describe the dynamics of your tomato supplies by season?
5. What is your sales strategy (information required include; storage, stock volumes at a time, branding, promotions, maximum shelf life, how prices and purchase prices are decided)
6. What are the major challenges you encounter in marketing tomato in particular compared to other stock that make up your merchandise?
7. How would you describe the competition that exists between your shop and informal traders selling tomato on the pavements and roadsides?

Thank You!

PRICE OBSERVATION SHEET FOR ANALYSING PRICE TRANSMISSION IN TOMATO MARKETS OF LIMPOPO PROVINCE, SOUTH AFRICA: (by Mandizvidza. K, of the University of Limpopo)

DATA SOURCE:_____

DATE	TOMATO PACKAGE DESCRIPTION/SIZE	AVERAGE PRICE PER KILOGRAM