PRICE TRANSMISSION AND CAUSALITY ANALYSIS OF CHEESE AND PASTEURISED LIQUID MILK IN SOUTH AFRICA FROM 2000 TO 2016

by

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ABSTRACT

The relationship between farm and retail prices provides insights into marketing efficiency, consumer and farmer welfare. In light of this, much focus has been given to price transmission studies. Thus, price transmission studies have become increasingly important in Sub Saharan Africa because of its nature of providing clear insights information into our markets. Despite its importance in markets, there are a few studies analysing the mechanism through which prices are determined and transmitted from farm gate to retail markets in dairy markets in South Africa.

The aim of the study was to investigate and analyse the nature of price transmission mechanism of pasteurised liquid milk and cheese in South Africa. The specific objectives were to determine the correlation between the milk production and quantity of milk processed in South Africa. Furthermore, there was a need to determine the direction of causality between the farm gate, processor and retail prices of cheese and pasteurised liquid milk in South Africa. It was also necessary to determine whether the price transmission of pasteurised liquid milk and cheese was symmetric or asymmetric in South Africa. The study used secondary time series data that covered a sample size of 17 years (2000 -2016) of pasteurised liquid milk and cheese in South Africa. Pearson correlation coefficient, Granger causality test and Vector Error Correction Model were used for data analysis.

Pearson correlation results revealed that milk produced is perfectly correlated with the quantity of milk processed and it was positive. The Granger causality tests revealed that there was a no causal relationship between farm gate and processor, retail and processor and also between farm gate and retail for cheese. However, signs of independent causal relationship from farm gate to retail prices were visible. It also suggested a bidirectional causal relationship between processor and farm gate prices and also between retail and processor prices of pasteurised liquid milk. On the other hand, a unidirectional causality was found from retail to farm gate prices. The VECM results for pasteurised liquid milk showed asymmetric price transmission implying that retailers and processors react quicker to price increases than to price decrease.

It is recommended that more focus be placed on investment in emerging dairy farmers in order to increase production. This can be done through the input price subsidies, grants and education on modern technologies. The government should also implement the price monitoring cell in order to protect the consumers from unfair prices passed on by the retailers.

Key words: Price transmission, Dairy markets, VECM, Granger causality

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DECLARATION

I, Tshegofatso Ramoshaba 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 been previously submitted by me for the degree at this or any other University, that it is my own work and all materials contained herein have been duly acknowledged.

________________________ __________________

Signature Date

DEDICATION

This piece of work is dedicated to my late mom (Mamolatelo Mokgadi Ramoshaba). It is to show that the faith and power you instilled in me made me who I am today. It is unfortunate and very sad that you are not here to witness the professional young woman I am today. I am where I belong, *Mma*. Indeed: “Those we love don’t go away, they walk beside us every day…Unseen, unheard, but always near. Still loved, still missed and very dear” ~ Anonymous. *Robala ka khutso Noko!*

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LIST OF ACRONYMS

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
AR	Autoregressive model
ARMA	Autoregressive and Moving Average model
ARIMA	Autoregressive Integrated Moving Average model
BFAP	Bureau for Food and Agricultural Policy
CIA	Cumulative Impact Asymmetry
CONIA	Contemporary Impact Asymmentry
DAFF	Department of Agriculture, Forestry and Fisheries
DFP	First difference of Farm gate Prices
DLEA	Distributed Lag Effect Asymmetry
D*log*FP	First differenced natural Logarithm of Farm gate Price
D*log*PP	First differenced natural Logarithm of Processor Price
D*log*RP	First differenced natural Logarithm of Retail Price
DPP	First difference of Processor Prices
DRP	First difference of Retail Prices
DW	Durbin Watson
EAPA	Equilibrium Adjustment Path Asymmetry
ECM	Error Correction Model
ECT	Error Correction Term
EViews	Econometric Views
FAO	Food and Agriculture Organization

FGP	Farm Gate Price
FGPC	Farm Gate Price for Cheese
FGPPLM	Farm Gate Price for Pasteurised Liquid Milk
HQIC	Hannan-Quinn Information Criterion
IDC	International Dairy Federation
*log*FGP	Natural Logarithm of Farm gate Price
*log*PP	Natural Logarithm of Processor Price
*log*RP	Natural Logarithm of Retail Price
MA	Moving Average model
MEAPA	Momentum Equilibrium Path Adjustment Asymmetry
MP	Milk Produced
MPO	Milk Producers Organisation
NAMC	National Agricultural Marketing Council
OLS	Ordinary Least Squares
PP	Philips Perron test
PP	Processor Price
PPC	Processor Price for Cheese
PPPLM	Processor Price for Pasteurised Liquid Milk
QMP	Quantity of Milk Processed
RP	Retail Price
RPC	Retail Prices for Cheese
RPPLM	Retail Prices for Pasteurised Liquid Milk
RSA	Republic of South Africa

RTA	Reaction time Asymmetry
SA	South Africa
SIC	Schwarz Information Criterion
Stats SA	Statistics South Africa
US Dollar	United States Dollar
VAR	Vector Auto Regressive model
VLOSC	VAR Lag Order Selection Criteria

CHAPTER ONE:
INTRODUCTION

1.1 Background of the study

Dairy is a universal agricultural production and it is a well-known fact that the industry actively contributes to the economies of a number of communities, regions and countries (International Dairy Federation, 2013). South African milk production contributes approximately 0.5% to the world milk production; with four major breeds being Holstein, Jersey, Guernsey and Ayrshire. The industry comprises of a number of different economic activities and significant differences exist between farming methods and processing of dairy products. These activities involve the production and marketing of raw milk, pasturised milk and cream, fermented milk, long-life milk and cream, yoghurt, cheese and its by-product whey, milk powder, sweetened and unsweetened concentrated milk, butter and butter oil (Department of Agriculture, Forestry and Fisheries, 2014).

Whole fresh cow milk is South Africa’s third largest agricultural product in terms of production (tonnage) and the fifth most important in terms of value. Milk production has risen steadily over the last decade and currently stands at around 28 billion litres (Coetzee, 2015). According to Midgley (2016), South African dairy production is responsive to the growing domestic and regional demand but is also sensitive to the producer price. Increased milk production is stimulated when the producer price for milk rises above a certain edge. The dairy sector’s primary contribution is to national food security and the domestic economy. Nevertheless, it is increasingly supplying neighbouring countries with milk products, encouraged by the drop in the value of the rand and the attractive international price of milk (in US dollars).

The dairy supply value chain consists of large commercial, medium and small dairy producers, bulk milk collectors, importers, dairy processors, exporters, transport operators, retailers, informal traders and consumers. Producers have been forced into a “price-taking” role in negotiations with milk buyers, resulting in low prices to producers. To maintain profitability at production level, the dairy sector has thus seen a reduced number of producers, increasing herd sizes and greater efficiencies of production (Midgley, 2016).

In a document by DAFF (2014), it was stated that the producer price of fresh milk influences the quantity produced, and both determine the total gross value of production nationally. This value is steadily increasing and stood at R11.6 billion in 2012/13. Most of the milk produced is for local consumption: 95% is sold in the formal market and 2% informally; the rest is used for own consumption and calves. Traditionally, milk production in South Africa has been fairly in line with demand and shortages are seldom experienced. In addition, milk and dairy products are both exported and imported.

According to the Bureau for Food and Agricultural Policy (2015), the producer price of raw milk has seen two periods of rapid increase in the last 10 years, from 2006/07 to 2009/10, and again since 2011/12. The domestic drought and rising cost of feed grain placed pressure on production. However, higher prices, partly because of the drop in the exchange rate, and good demand have balanced this out and production has continued to increase.

The economic value of the dairy industry is spread throughout the supply chain, but there has been a dispute or disputes between producers and processors around low producer milk prices. Producers have been forced into a “price-taking” situation owing to their large numbers and lack of product differentiation. This has led to many of the smaller producers leaving the industry or being bought out by larger dairies. The number of milk producers decreased from 3,899 in January 2007 to 1,834 in January 2015 dropping by 53% (Coetzee, 2015).

According to Funke (2006), prices in the supply chain are established through negotiations between farmers and buyers (dairy companies), and between processors and retailers. Farmers predominantly remain “price takers” in this system and experience continuous “price-cost squeeze” and affordability to the consumer is also taken into account.

South African dairy industry has a dual nature where we have liquid and concentrated products. Pasteurised liquid milk and UHT milk are the major liquid products, while hard and semi-hard cheese is the major concentrated product (Department of Agriculture, Forestry and Fisheries, 2014). The study had a representation of both the liquid and concentrated products and they were chosen based on their contribution and availability of historical data for the study. Concentrated milk products consist of 57% Cheese while the Pasteurised liquid milk consists of 34% market share of the liquid milk, hence the study focused on the two products.

The study addresses the price transmission and causality analysis. Antonova *et al* (2013) defined Price transmission as a statistical relationship between prices, which might be either horizontal (special) between certain markets or regions, or vertical, such as from farm to retail level.

According to Granger (1969), Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another and it is based on predictions. That is, Granger causality tests are used to assess the causal links between the prices.

1.2 Problem statement

South African dairy market is divided into 60% liquid and 40% concentrated products. (Department of Agriculture, Forestry and Fisheries, 2014). Milk is the main raw material for dairy products and has a high demand in both domestic and international markets. Milk value chain ranges from producers or farmers, processors, retailers and consumers. However, prices play an imperative role linking these different levels of the market. Milk producers, processors and retailers encounter unequal and unstable prices that lead to losses and underproduction of milk in most developing countries, particularly in South Africa. These changes in prices lead to low productivity, market failure and marketing inefficiencies. The extent to which a price shock at one point affects a price at another point can broadly indicate whether efficient arbitrage exists in the space between levels of markets. According to Kharin (2015), rising food prices can provide an opportunity for agricultural and economic development, if price changes at one level were efficiently transmitted to another level. Thus, marketing efficiencies will be realised along the value chain. However, little is still known in terms of who along the marketing levels and value chain, benefits more from changes in the prices in South Africa. Thus, this study attempted to bridge this research information gap by investigating the price transmission mechanism of pasteurised liquid milk and cheese in South Africa from 2000 to 2016.

1.3 Rationale of the study

Price transmission in agricultural markets has been a subject of numerous studies (Vavra and Goodwin, 2005; Lajdova and Beilik, 2013) and the asymmetry in price transmission has been detected in most agricultural products. According to FAO (2004), the degree of price transmission can provide at least a broad assessment of the extent to which markets are functioning in a predictable way. What is noteworthy is that price signals are passing through consistently between different markets. The interest in price transmission studies has recently gained remarkable momentum and the amount of studies on this subject is rapidly growing (Vavra and Goodwin, 2005). However, the same cannot be said in South Africa, as there is limited research on the subject particularly in the industry. The study attempted to offer a contribution towards providing some clear insights into market efficiency issues as well as providing an understanding of the impact of price transmission on the welfare of farmers respectively.

1.4 Scope of the study

1.4.1 Aim of the Study

The aim of the study was to investigate and analyse the nature of price transmission mechanism of pasteurised liquid milk and cheese in South Africa from 2000 to 2016.

1.4.2 Objectives of the study

The objectives of the study were to:

i. Determine the correlation between milk production and the quantity of milk processed in South Africa from 2000 to 2016.

ii. Determine the direction of causality between farm gate prices, the processor prices and retail prices of cheese and pasteurised liquid milk in South Africa from 2000 to 2016.

iii. Determine whether the price transmission of pasteurised liquid milk and cheese are symmetric or asymmetric in South Africa from 2000 to 2016.

1.4.3 Research hypotheses

The study hypothesized the following:

i. There is no correlation between milk production and the quantity of milk processed in South Africa from 2000 to 2016.

ii. There is no causal relationship between the farm gate, the processor and consumer prices of cheese and pasteurised liquid milk in South Africa from 2000 to 2016

iii. The price transmission of cheese and pasteurised liquid milk in South Africa is neither symmetric nor asymmetric.

1.5 Organisational structure

The rest of this report is structured into the remaining chapters, namely; Chapter two, Chapter three, Chapter four and Chapter five. Chapter two on literature review, discusses concepts and provides reviews on how other authors have undertaken the subject of price transmission in South Africa and the rest of the world. Chapter three explains the methodology applied to this study, which includes the study area, data collection methods, data analysis and models. Chapter four covers the quantitative analyses performed, as well as key findings of this study. Chapter five provides the summary, conclusion and possible recommendations to policy makers.

CHAPTER TWO:
LITERATURE REVIEW

2.1 Introduction

The chapter offers the foundations on which this research is based on. It reviews literature on numerous concepts, methods and techniques used in the study. A comprehensive description of terminologies and a review of previous studies undertaken of price transmission in South Africa and elsewhere in the world.

2.2 Definition of key concepts

2.2.1 Price transmission

Price transmission is a broad concept that can be explained in different ways. It is the situation where changes in one price are completely and instantaneously transmitted to the other price, as postulated by the Law of One Price. It is the extent to which a price series at one location causes changes in, or correlates with price changes at another location as postulated by (Colman, 1995). According to Abdulai and Tietje (2007), the applied value of price transmission studies is useful to policy makers in many respects. For example, countries that liberalise their domestic markets require knowledge on how the world price signals are transmitted to their domestic markets. Price transmission answers the question, how quickly and to what extent are changes in farm prices transmitted to the processor and retail levels and vice versa. There are two types of price transmission which are asymmetric and symmetric price transmission.

a. Asymmetric price transmission

According to DairyCO (2010), prices are said to be asymmetric if they move in the same direction but not at the same time. Usually, a price movement in one part of a supply chain will result in a similar price movement in another related part of the supply chain, after a typical delay or “lag” period. 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 because 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 other aspect which is direction ascertains the extent to which adjustments contrast, depending on whether a shock is transmitted upwards or downwards the supply chain.

Meyer and Von Cramon-Taubadel (2004) explained the price asymmetric based on four aspects, which include positive asymmetry, negative asymmetry, asymmetry in magnitude and asymmetry in speed. 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. 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. Asymmetry in magnitude measures whether there is a more/less than proportionate change in downstream prices in response to a price shock upstream.

Manera and Frey (2005) prolonged the classifications of asymmetry to include new methods of measuring asymmetry which included contemporary impact asymmetry, distributed lag effect asymmetry, cumulative impact asymmetry, reaction time asymmetry, equilibrium adjustment path asymmetry, momentum equilibrium, regime effect asymmetry, regime equilibrium adjustment path asymmetry and spatial asymmetry. The descriptions of the methods are offered below;

i. Contemporary Impact Asymmetry (CONIA)

A widely held view is that shocks arising from changes in the upstream (input) prices are transmitted rapidly and completely to the downstream (output) prices. The impact of the positive and negative shocks on the downstream (output) prices and how the downstream (output) prices respond to these shocks define the contemporaneous relationship between the two market prices. The statistical test that shows whether this hypothesised relationship really exists has been the focus of many asymmetric price transmission studies for the past two decades. If this hypothesis is not supported by the statistical test, it implies that the contemporaneous relationship between the prices is symmetric.

ii. Distributed Lag Effect Asymmetry (DLEA)

Distributed Lag Effect Asymmetry (DLEA) is asymmetry that results from the response of output prices to positive or negative changes in the upstream input prices that may not be instantaneous but distributed over a time lag. Several explanations have been made as to the cause of this delayed response. The explanations date back to the 1980s, menu cost (Heien,1980), market imperfection (Ward, 1982), and the inertia involved in the storing, transporting and processing of food products have been cited as possible reasons for DLEA.

iii. Cumulative Impact Asymmetry (CIA)

Manera and Frey (2005), noted that this type of asymmetry relates to whether there is a cumulative impact of contemporaneous and distributed lag effects on the upstream-downstream market price relationship. If the contemporaneous impact occurs at the same lag, the cumulative impact is symmetric, otherwise it is asymmetric. However, the joint existence of contemporaneous impact and Distributed Lag Effect is a sufficient but not a necessary condition for cumulative impact asymmetry.

iv. Reaction Time Asymmetry (RTA)

If there is a positive and/or negative shock to the upstream (input) price, the tendency is that the downstream (output) price will readjust to an equilibrium level depending on whether an equilibrium relationship exists between the prices. The readjustment to equilibrium level is not instantaneous but takes a time lag. The time taken for the downstream (output) price to readjust to an asymmetric upstream shock is termed Reaction Time Asymmetry (RTA) and this can give an indication as to the nature of the upstream shock – that is, whether it is persistent or transitory

v. Equilibrium Adjustment Path Asymmetry (EAPA)

According to Uchezuba (2010), this is the type of asymmetry in response to adjustment towards equilibrium path. Adjustment toward equilibrium depends on the stationarity of the economic variables. Stationary stochastic series reverts back to equilibrium, while non-stationary series does not return to the equilibrium path. Engle and Granger (1987) developed an equilibrium term and proposed that a linear combination of non-stationary series has a long–run cointegrating equilibrium relationship depending on the level of the equilibrium term (also called error correction term). This implies that adjustment to the equilibrium will depend on whether the equilibrium term is above or below the equilibrium level. If adjustment towards equilibrium is above or below equilibrium level, EAPA results. In contrast, if the adjustment remains at the same equilibrium level, this results in symmetric equilibrium adjustment path.

vi. Momentum Equilibrium Path Adjustment Asymmetry (MEAPA)

Enders and Granger (1998) proposed that adjustment could be allowed to depend on the previous period's change in the equilibrium term in such a way that an asymmetric adjustment will exhibit more momentum in one direction than the other. This type of adjustment is termed Momentum Equilibrium Path Adjustment Asymmetry.

vii. Spatial asymmetry

Meyer and Von Cramon-Taubadel (2004), indicate that spatial asymmetry can be classified according to the speed and magnitude of price transmission and according to whether it is positive or negative. This is a type of asymmetric price relationship between spatially separated markets.

Asymmetric price transmission implies that consumers are not benefiting from a price reduction at the producers' level, or producers might not benefit from a price increase at the retail level. Thus, under asymmetric price transmission, the distribution of welfare effects across levels and among agents, following shocks to a market will be altered relative to the case of symmetric price transmission.

Asymmetric price transmission can be measured and tested by various methods depending on what the researcher aims to do. *Snyder et al* (1998), note that the researcher's choice of the methods to be used depends on the data available, the budget for the study and the type of questions that need to be answered. Some researchers use primary data which they themselves collect and others prefer the use of secondary historical data. However, according to literature, the most widely used method for testing asymmetric price transmission is the time series model.

This model is based on the assumption that the agricultural product included in the production process is the largest cost component of the final consumer good. The assumption made is important because the higher the cost component the more direct the effect of increases and decreases of farm prices on retail prices, since few other cost components come into play. Thus, they investigate whether increases and decreases in farm prices are reflected in or transmitted to retail prices. Thus, co-integrated variables can be tested for price transmission

2.2.2 Correlation Analysis

According to Sims (2012), correlation analysis is a method of statistical evaluation used to study the strength of a relationship between two, numerically measured, continuous variables (e.g. milk produced and quantity of milk processed). This particular type of analysis is useful when a researcher wants to establish if there are possible connections between variables. It is often misunderstood that correlation analysis determines cause and effect; however, this is not the case because other variables that are not present in the research may have impacted on the results.

If correlation is found between two variables, it means that when there is a systematic change in one variable, there is also a systematic change in the other; the variables alter together over a certain period of time. If the correlation is found, depending on the numerical values measured, this can either be positive or negative.

Positive correlation exists if one variable increases simultaneously with the other, i.e. the high numerical values of one variable relate to the high numerical values of the other.

Negative correlation exists if one variable decreases when the other increases, i.e. the high numerical values of one variable relate to the low numerical values of the other.

Pearson's product-moment coefficient is the measurement of correlation and ranges (depending on the correlation) between +1 and -1. A value of +1 indicates the strongest positive correlation possible, and -1 indicates the strongest negative correlation possible. Therefore, the closer the coefficient to either of these numbers the stronger the correlation of the data it represents. On this scale, 0 indicates no correlation, hence values closer to zero highlight weaker/poorer correlation than those closer to +1/-1.

2.2.3 Time series data

Asteriou and Hall (2007), defined time series data as a set consisting 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 RP represents the Retail Price of cheese from May to February 2007 then we can represent it as: Y_t for *t*=1, 2, 3..., T where t =1 for May 2007 and *t* = T for December 2007. It can also be defined as a sequence of data points, measured typically at successive times, spaced apart at uniform intervals (Vavra and Goodwin, 2005).

2.2.4 Stationarity

A common assumption in many time series techniques is that the data are stationary. Engineering Statistics Handbook (2012), explains stationary as the process that has the property that the mean, variance and autocorrelation structure do not change over time. Stationarity can be defined in precise mathematical terms. In this study, however, it is a flat looking series, without trend, constant variance over time, a constant autocorrelation structure over time and no periodic fluctuations.

Koop (2000) used a criterion where 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 $Y_t = \partial Y_{t-1} + u_t$ the criteria for testing whether Yt is stationary is as follows;

i. In the AR (1) model, if $\partial = 1$, then Y_t has a unit root.

If however, $|\partial| < 1$ then Y_t is stationary.

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

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

iv. If $\mathrm{Y_t}$has a unit root then the series will exhibit a trend behaviour especially if the intercept is non-zero,

v. If $\mathrm{Y_t}$ has a unit root, then $\Delta\mathrm{Y_t}$ will be stationary. That is the reason why all series that have unit roots are often referred to as difference stationary series.

Engineering Statistics Handbook (2012) also provides information on how the non-stationary time series can be solved. If there is non-stationarity, the data can be transformed techniques discussed below. The time series data can be differenced. That is, given the series Z_t, a new series is created

$$Y_i = Z_i - Z_i - 1 \qquad \text{(Equation 2.1)}$$

The differenced data will contain one less point than the original data. Although you can difference the data more than once, one difference is usually sufficient.

If the data contain a trend, one can then can fit some type of curve to the data and then model the residuals from that fit. Since the purpose of the fit is to simply remove long term trend, a simple fit, such as a straight line, is typically used.

For non-constant variance, taking the logarithm or square root of the series may stabilise the variance. For negative data, one can add a suitable constant to make all the data positive before applying the transformation. This constant can then be subtracted from the model to obtain predicted (i.e., the fitted) values and forecasts for future points.

a. Trend Stationarity

Nielsen (2005) explains the trend stationarity in a form of equations. Considering a stationary AR (1) model with a deterministic linear trend term as:

$$Y_{t} = \theta Y_{t-1} + \delta + \gamma_t + t, t = 1, 2, \ldots, T, \qquad \text{(Equation 2.2)}$$

where |θ| < 1, and Y0 is an initial value. The solution for Yt (MA-representation) has the form

$$Y_t = \theta_t Y0 + \mu + \mu_{1t} + t + \theta_{t-1} + \theta 2_{t-2} + \theta 3_{t-3} + \cdots \qquad \text{(Equation 2.3)}$$

Note that the mean, $EY_t = \theta_t Y0 + \mu + \mu_{1t} \rightarrow \mu + \mu_{1t}\ for\ T \rightarrow \infty$ contains a linear trend, while the variance is constant:

$$V[Y_t] = V[t + \theta_{t-1} + \theta 2_{t-2} + \cdots = \sigma 2 + \theta 2 \sigma 2 + \theta 4 \sigma 2 + \cdots = \sigma 2_{1-\theta 2} \qquad \text{(Equation 2.4)}$$

The original process, Yt, is not stationary. The deviation from the mean,

$Y_t = Y_t - E[Y_t] = Y_t - \mu - \mu_{1t}$ is a stationary process. The process Yt is called trend-stationary

2.2.5 Testing for unit root

Unit root is a feature of some stochastic processes that can cause problems in statistical inference involving time series models. A linear stochastic process has a unit root if 1 is a root of the process' characteristic equation.

Consider the AR (1) model with a unit root, θ =1:

$$Y_t = Y_{t-1}\ \delta + t, t = 1,2, .., T, \qquad \text{(Equation 2.5)}$$

or $\Delta Y_t = \delta + t,$

where $Y0$ is the initial value.

Note that $Z = 1$ is a root in the autoregressive polynomial,

$\theta(L) = (1 - L).\theta L$ is not invertible and Y_t is non-stationary.

The processΔY_t is stationary. We denote Y_t a difference stationary process.

If ΔY_t is stationary while Y_t is not, Y_t is called integrated of first order, I(1).

A process is integrated of order d, I(d), if it contains d unit roots.

The solution for Y_t is given by $Y_t = Y_0 + X_t\ i = 1\ \ \Delta Y_t = Y_0 + X_t i = 1\ (\delta + i)\ \ Y_0 + \delta_t\ X_t$ (Equation 2.6)

$i = 1, i,$ with moments

$E[Y_t] = Y_0 + \delta_t\ and\ V[Y_t = t.\sigma_2$

2.2.6 Dickey Fuller test

The Augmented Dickey-Fuller test (ADF) was used with serial correlation. The ADF test can handle more complex models than the Dickey-Fuller test, and it is more powerful. That said, it should be used with caution because–like most unit root tests–it has a relatively high Type I error rate (Dickey and Fuller, 1979).

The hypotheses for the tests were:

I. The null hypothesis for this test is that there is a unit root.

II. The alternate hypothesis differs slightly according to which equation one is using. The basic alternate is that the time series is stationary (or trend-stationary).

2.2.7 Granger causality

Causality is the natural or worldly agency or efficacy that connects one process with another process or state, where the first is partly responsible for the second, and the second is partly dependent on the first. It is to some extent different to how the concept is perceived in everyday use. Asteriou and Hall (2007) view the concept of causality as, the ability of one variable to predict (thus cause) the other.

Granger (1969) initiated the concept of causality that has commonly gained popularity as the "Granger causality test" in trying to address whether one variable is causally related to another. For instance, retail prices are said to granger cause farm gate prices if the past and present information of retail prices can be used to predict the farm gate prices.

Asteriou and Hall (2007) demonstrate how Granger causality tests for the case of two stationary variables Z_t and Y_t is done in the context of VAR models. The models are depicted by equations 2.7 and 2.8;

$Z_t = a_1 + \sum iY_{t-i} + \sum jZ_{t-j} + e_{1t}$ (Equation 2.7)

$Y_t = a_2 + \sum iY_{t-i} + \sum jZ_{t-j} + e_{2t}$ (Equation 2.8)

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

i. The lagged Y terms in equation 2.7 may be statistically different from zero as a group and the lagged Z terms in equation 2.8 not statistically different from zero. In this case Y_t causes . Z_t

ii. The lagged Z terms in equation 2.8 maybe statistically different from zero as a group while the lagged Y terms in equation 2.7 may not be statistically different from zero. In this case Z_t causes Y_t

iii. Both sets of Y and Z terms are statistically different from zero in equation 2.7 and equation 2.8 so that we have bi-directional causality

iv. Both sets of Y and Y terms are not statistically different from zero in both equations 2.7 and 2.*8* so that Y_t is independent of Z_t .

2.3 Review of previous studies on price transmission

2.3.1 Previous studies conducted in South Africa

Uchezuba (2010) measured asymmetric price and volatility spillover in the broiler value chain in South Africa using farm and retail poultry prices, as well as the daily near market monthly spot prices for yellow maize, sunflower seed and soybeans. The study applied M-TAR model for regressions and the results showed asymmetric relationship between farm and retail prices. The retail price was found to respond asymmetrically to both positive and negative shocks arising from changes in producer prices, but the response is greater when the shocks are negative, thus, when the producer price rises to lower marketing margins in the value chain. The sizes of the adjustment parameters in the farm-retail combination reveal that retail prices do not respond to shocks completely and instantaneously, but respond within a distributed time lag. They also revealed that farm price granger cause retail price, implying that retailers depend on what happens at the farm level in order to form their market expectations.

A widening farm to retail price spread was concluded to be an indication of a decline in the farmers' share of the retail price (Funke, 2006). The conclusion was based on the results they found which indicated 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. 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. Nonetheless, the economic models used to test asymmetric price behaviour in these supply chains did not show any form of significance. This may be because of the presence of asymmetric price transmission, a lack of accurate data and possible unjust marketing behaviour by role players within the supply chains.

On an analysis of price transmission in tomato markets of Limpopo Province, South Africa, Mandizvidza (2013), found that the farmers' portion of the consumer's rand is low. Approximately 85.1% of the consumer's rand goes to pay for marketing margins. The study 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. Retailers are quick to react to increases in farm gate prices and slow in adjusting to price decreases. Mandizvidza (2013), also found a symmetric relationship from wholesale to farm gate. Thus, the transmission of price information is more efficient between the farm and wholesale markets than between the farm and retail markets. However, there is a scope for increasing efficiency of tomato marketing in the province.

2.3.2 Previous studies conducted internationally

Abdulai and Tietje (2007) studied spatial price transmission and asymmetry in the Ghanaian maize markets. The study applied threshold co-integration tests and the results indicated a high degree of integration in major maize markets of Ghana. Nonetheless, the results of the threshold co-integration 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.

DairyCo (2011) reported a study that considers price movements in the milk commodity, cheese and liquid milk supply chains using data from 1990. Empirical results showed evidence of asymmetric pricing in all of the supply chains investigated. The strength of the evidence in each chain varies, with some only demonstrating asymmetric pricing for a small part of the period investigated and others showing it for much longer periods.

Types of price movements also vary between the parts of the supply chain considered– with some illustrating asymmetric movements between farmer and processor while examples are also highlighted between processor and retailer (DairyCo, 2011). It is noted that where asymmetric price movements have been identified, they are never to the benefit of the farmer. This is because farmers are price takers and are unable to influence relevant wholesale prices. Instead, the greater bargaining power of other market participants in the chains means that, at times, they can ensure they benefit from price movements by taking certain actions.

Bolotova and Novakovic (2011) noted about five major causes of price asymmetry between levels, as revealed in various 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.

2.4 Summary

Previous studies conducted in South Africa and all over the world provided evidence of price asymmetry in different markets e.g. tomatoes, broiler, etc. However, not enough information about the dairy industry in South Africa specifically Cheese and Pasteurised liquid milk is documented. Thus, the study was introduced to provide the market insights of the dairy market in South Africa and to fill the information gap.

CHAPTER THREE:
RESEARCH METHODOLOGY

This chapter gives an overview of the research methods used to conduct the study. Attention is placed on the choice of study area, data collection technique and the econometric model.

3.1 Description of study area

The study was conducted in South Africa (SA). South Africa, officially the Republic of South Africa (RSA), is the southernmost country in Africa. It is bounded on the south by 2,798 kilometres (1,739 mi) of the coastline of Southern Africa stretching along the South Atlantic and Indian Oceans on the north by the neighbouring countries, namely; Namibia, Botswana, and Zimbabwe; and on the east and northeast by Mozambique and Swaziland; and surrounds the kingdom of Lesotho. South Africa is the largest country in Southern Africa and the 25th-largest country in the world by land area and, with close to 56 million people. It is the world's 24th-most populous nation.

Milk is produced in nearly all regions of South Africa. However, the coastal areas are more suitable because of mild temperatures and good rainfall, ensuring good-quality natural and artificial pastures. Ninety-eight (98%) percent of the milk is sold to the formal market and is processed mainly to liquid milk (UHT and pasteurised) and cheese (Lassen, 2012).

According to the Milk Producers' Organisation (MPO), the estimated number of commercial milk producers in the country decreased by 8,2% from 1 834 in January 2015 to 1 683 in January 2016. In 2015, the Eastern Cape province contributed 30,6% to the total milk production, Western Cape (26,5%), KwaZulu-Natal (25,7%), Free State (6,1%), North West (4,7%), Gauteng (2,9%) and Mpumalanga (2,1%), with the remaining two provinces contributing 1,4%.

3.2 Data collection

The study used secondary time series data which was obtained from the Department of Agriculture, Forestry and Fisheries (DAFF), Milk Producers Organisation and Statistics SA covering a time period of 17 years (2000- 2016) using monthly data. Proceeding, Econometric Views software package 8 (EViews) was used for data analysis. Moreover, Farm gate Prices (FP), Processor Prices (PP), retail prices (CP) for pasteurised liquid milk and cheese, quantity of Milk Produced (MP) and Quantity of Milk Processed (QMP) were considered in the analysis.

3.3 Analytical Technique

Econometric methods were used to analyse the data collected with the use of tables. The econometric models were applied in order to describe the main features of the variables and examine the relationship between farm gate, processor and retail prices of cheese and pasteurised liquid milk.

3.3.1 Correlation coefficient analysis

In analysing the correlation, Pearson correlation coefficient was used. Rossiter (2017) explained correlation as a descriptive statistic that reveals if two variables are related to each other. The correlation between two variables numerically describes whether larger and smaller than average values of one variable are related to larger or smaller than average values of the other variable. It is measuring the strength and direction of a linear relationship between two variables.

The general model is defined as:

$$r_{xy} = \frac{n\sum(x_i y_i) - (\sum x_i)(\sum y_i)}{\sqrt{n\sum x_i^2 - (\sum x_i)^2}\sqrt{n\sum y_i^2 - (\sum y_i)^2}}$$ Equation 3.1

While the operational model is defined as:

$$r_{mp,qmp} = \frac{n\sum(MP_i QMP_i) - (\sum MP_i)(\sum QMP_i)}{\sqrt{n\sum MP_i^2 - (\sum MP_i)^2}\sqrt{n\sum QMP_I^2 - (\sum QMP_i)^2}}$$ Equation 3.2

MP = Milk produced in South Africa from 2000 -2016

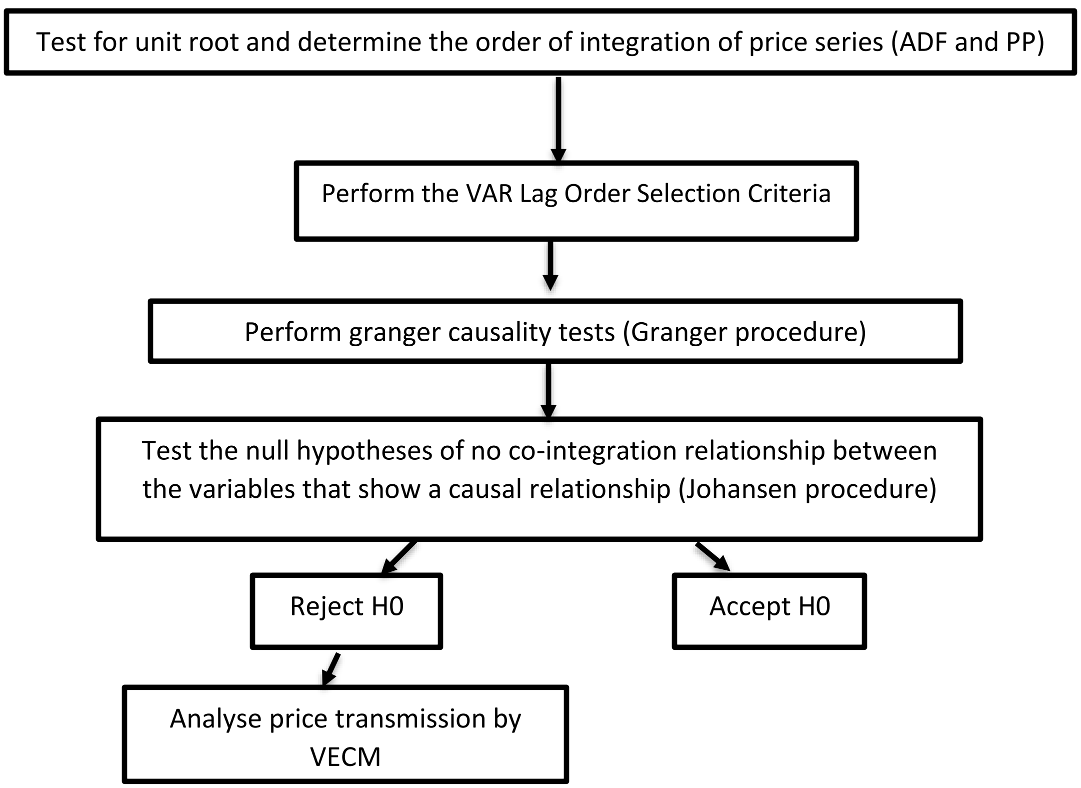
QMP = Quantity of milk processed in South Africa from 2000 -2016

N = Denotes the number of observations

∑ = Is the sum of the MP and QMP respectively

3.3.2 Conceptual framework for price transmission analysis

Figure 3.1: Framework for price transmission analysis



Source: Author compilation, 2018

Figure 3.1 summarises the methods and models applied in this study in analysing the price transmission of cheese and pasteurised liquid milk in South Africa from 2000- 2016. The first step was to examine each pair of logarithmic price series for order of integration using the Phillips-Perron tests and Augmented Dickey-Fuller tests (Dickey and Fuller, 1979). The tests were executed to test the price variables to see if they are non-stationary and to check the series' properties. According to Granger (1969), optimal lag length should be estimated prior to Granger Causality Tests, therefore the VAR Lag Order Selection Criteria was employed. This is because it facilitates the correct specification of the VAR model. Granger Causality Tests were then ran using the Granger procedure. This was done in order to check the causal relationship between the price series. Proceeding, Johansen Co-integration procedure was used to check the long run relationship between the variables. In circumstances where price series are found to be co-integrated, price transmission was analysed using VECM.

3.3.3 Investigating Unit root non-stationarity

Augmented Dickey Fuller and Phillips-Perron tests were carried out on farm gate, processor and retail prices of both pasteurised liquid milk and cheese to legitimately discover whether they contained a unit root. Vavra and Goodwin (2005) stated that a variable contains a unit root or is *I (1)* if it is non-stationary. In an event where the variables are non-stationary, there must be transformed first in order to proceed with economic analysis.

Three autoregressive forms of models were established, each for the three separate data series of FP, PP and RP in the way demonstrated below:

I. Cheese market

$$\Delta logFGPC_t = \sigma_1 + \sigma_2 t + \theta logFGPC_{t-1} + \sum_{t=1}^{p} \beta_i \Delta \log FGPC_{t-1} + e_t \quad \text{Equation 3.3}$$

$$\Delta logPPC_t = \sigma_1 + \sigma_2 t + \theta logPPC_{t-1} + \sum_{t=1}^{p} \beta_i \Delta \log PPC_{t-1} + e_t \quad \text{Equation 3.4}$$

$$\Delta logRPC_t = \sigma_1 + \sigma_2 t + \theta logRPC_{t-1} + \sum_{t=1}^{p} \beta_i \Delta \log RPC_{t-1} + e_t \quad \text{Equation 3.5}$$

Where ; σ_1 = is an intercept term

t = a trend term

$logFGPC_t$ = natural logarithm of farm gate price series to be tested in the cheese market

$logFGPC_{t-1}$ = natural logarithm of farm gate price series lagged by 1 period in the cheese market

$\sum_{i=1}^{p} \beta_i \Delta logFGPC_{t-1} =$ the 1st,2nd…pth lagged 1st differenced values of $logFGPC$ in the cheese market

$logPPC_t =$ natural logarithm of processor price series to be tested in the cheese market

$logPPC_{t-1} =$ natural logarithm of processor price series lagged by 1 period in the cheese market

$\sum_{i=1}^{p} \beta_i \Delta logPPC_{t-1} =$ the 1st,2nd…pth lagged 1st differenced values of $logPPC$ in the cheese market

$logRPC_t =$ natural logarithm of retail price series to be tested in the cheese market

$logRPC_{t-1} =$ natural logarithm of retail price series lagged by 1 period in the cheese market

$\sum_{i=1}^{p} \beta_i \Delta logRPC_{t-1} =$ the 1st,2nd…pth lagged 1st differenced values of $logRPC$ in the cheese market

$\sigma, \theta, \beta_i =$ coefficients

e_t =is the error term

II. Pasteurised liquid milk market

$\Delta logFGPPLM_t = \sigma_1 + \sigma_2 t + \theta logFGPPLM_{t-1} + \sum_{t=1}^{p} \beta_i \Delta \log FGPPLM_{t-1} + e_t$ Equation 3.6

$\Delta logPPPLM_t = \sigma_1 + \sigma_2 t + \theta logPPPLM_{t-1} + \sum_{t=1}^{p} \beta_i \Delta \log PPPLM_{t-1} + e_t$ Equation 3.7

$\Delta logRPPLM_t = \sigma_1 + \sigma_2 t + \theta logRPPLM_{t-1} + \sum_{t=1}^{p} \beta_i \Delta \log RPPLM_{t-1} + e_t$ Equation 3.8

Where ; $\sigma_1 =$ is an intercept term

$t =$ a trend term

$logFGPPLM_t =$ natural logarithm of farm gate price series to be tested in the pasteurised liquid milk market

$logFGPPLM_{t-1}$ = natural logarithm of farm gate price series lagged by 1 period in the pasteurised liquid milk market

$\sum_{i=1}^{p} \beta_i \Delta logFGPPLM_{t-1}$ = the 1st,2nd…pth lagged 1st differenced values of logFGPPLM in the pasteurised liquid milk market

$logPPPLM_t$ = natural logarithm of processor price series to be tested in the pasteurised liquid milk market

$logPPPLM_{t-1}$ = natural logarithm of processor price series lagged by 1 period in the Pasteurised liquid milk market

$\sum_{i=1}^{p} \beta_i \Delta logPPPLM_{t-1}$ = the 1st,2nd…pth lagged 1st differenced values of logPPPLM in the pasteurised liquid milk market

$logRPPLM_t$ = natural logarithm of retail price series to be tested in the pasteurised liquid milk market

$logRPPLM_{t-1}$ = natural logarithm of retail price series lagged by 1 period in the pasteurised liquid milk market

$\sum_{i=1}^{p} \beta_i \Delta logRPPLM_{t-1}$ = the 1st,2nd…pth lagged 1st differenced values of logRPPLM in the pasteurised liquid milk market

σ, θ, β_i = coefficients

e_t =is the error term

The null hypothesis H0: ø = 0 (unit root) was tested with the alternative hypothesis specified as H1: 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 H0 would infer that the process that generates PP series of data is time uniform (i.e. PP is stationary); otherwise the series would be non-stationary implying that differencing methods should be applied to the data to get rid of the unit root.

3.3.4 Granger Causality Model

Granger Causality Model was used to analyse the direction of causality of cheese and pasteurised liquid milk in South Africa.

According to Konya (2004), the concept of Granger causality is centered on the idea that a cause come before its effect. Producer Price (PP) is said to Granger-cause farm gate price (FMP), if the current value of FMP is conditional on the past values of PP (PP_{t-1}, PP_{t-2}..., PP_0) and thus the history of producer prices is likely to help predict Farm gate prices. Causation between farm gate prices (FGP), processor prices (PP) and retail prices (RP) are going to be tested.

a) Cheese market

Farm gate and processor prices equation

$$logFGPC_t = \alpha + \sum_{t=1}^{k} \beta \log FGPC_{t-i} + \sum_{t=1}^{k} \gamma \log PPC_{t-i} + u_t \quad \text{Equation 3.9}$$

$$logPPC_t = \alpha + \sum_{t=1}^{k} \beta \log PPC_{t-i} + \sum_{t=1}^{k} \gamma \log FGPC_{t-i} + u_t \quad \text{Equation 3.10}$$

Processor and retail prices equation

$$logPPC_t = \varepsilon + \sum_{t=1}^{k} \gamma logPPC_{t-i} + \sum_{t=1}^{k} \upsilon logRPC_{t-i} + u_t \quad \text{Equation 3.11}$$

$$logRPC_t = \varepsilon + \sum_{t=1}^{k} \gamma logRPC_{t-i} + \sum_{t=1}^{k} \upsilon logPPC_{t-i} + u_t \quad \text{Equation 3.12}$$

Retail and farm gate prices equation

$$logRPC_t = \theta + \sum_{t=1}^{k} \upsilon logRPC_{t-i} + \sum_{t=1}^{k} \beta logFGPC_{t-i} + u_t \quad \text{Equation 3.13}$$

$$logFGPC_t = \theta + \sum_{t=1}^{k} \upsilon logFGPC_{t-i} + \sum_{t=1}^{k} \beta logRPC_{t-i} + u_t \quad \text{Equation 3.14}$$

Where;

FGPCt = Farm gate prices at time for cheese

PPCt = Processor prices at time for cheese

RPCt = Retail prices at time for cheese

$FGPC_{t-i}$ = Lagged farm gate prices at time for cheese

PPC_{t-i} = Lagged processor prices at time for cheese

RPC_{t-i} = Lagged retail prices at time for cheese

k = Is the optimal lag length

β, θ, υ = Are the coefficients to be estimated

U_t = Is the error term

b) Pasteurised liquid milk market

Farm gate and processor prices equation

$$logFGPPLM_t = \alpha + \sum_{t=1}^{k} \beta \log FGPPLM_{t-i} + \sum_{t=1}^{k} \gamma \log PPPLM + u_t \quad \text{Equation 3.15}$$

$$logPPPLM_t = \alpha + \sum_{t=1}^{k} \beta \log PPPLM_{t-i} + \sum_{t=1}^{k} \gamma \log FGPPLM + u_t \quad \text{Equation 3.16}$$

Processor and retail prices equation

$$logPPPLM_t = \varepsilon + \sum_{t=1}^{k} \gamma logPPPLM_{t-i} + \sum_{t=1}^{k} \upsilon logRPPLM_{t-i} + u_t \quad \text{Equation 3.17}$$

$$logRPPLM_t = \varepsilon + \sum_{t=1}^{k} \gamma logRPPLM_{t-i} + \sum_{t=1}^{k} \upsilon logPPPLM_{t-i} + u_t \quad \text{Equation 3.18}$$

Retail and farm gate prices equation

$$logRPPLM_t = \theta + \sum_{t=1}^{k} \upsilon logRPPLM_{t-i} + \sum_{t=1}^{k} \beta logFGPPLM_{t-i} + u_t \quad \text{Equation 3.19}$$

$$logFGPPLM_t = \theta + \sum_{t=1}^{k} \upsilon logFGPPLM_{t-i} + \sum_{t=1}^{k} \beta logRPPLM_{t-i} + u_t \quad \text{Equation 3.20}$$

Where;

FGPPLM = Farm gate prices at time for Pasteurised liquid milk

PPPLMt = Processor prices at time for Pasteurised liquid milk

RPPLMt = Retail prices at time for Pasteurised liquid milk

$FGPPLM_{t-i}$ = Lagged farm gate prices at time for Pasteurised liquid milk

$PPPLM_{t-i}$ = Lagged processor prices at time for Pasteurised liquid milk

$RPPLM_{t-i}$ = Lagged retail prices at time for Pasteurised liquid milk

k = Is the optimal lag length

β, θ, υ = Are the coefficients to be estimated

U_t = is the error term

Equation 3.9 and 3.15 imply that current farm prices are dependent on past farm prices, past and present processor prices in cheese and pasteurised liquid milk markets respectively. It also hypothesises that current processor prices are dependent on past farm gate prices and past and present processor prices.

The mathematical statement of equation 3.11 and 3.17 means that the current processor prices are dependent on past processor prices and past and present retail prices. Likewise, the second mathematical statement assumes that current retail prices are dependent on past processor prices and past and present retail prices.

Equation 3.13 and 3.19 postulates that current farm gate prices are dependent on past farm gate prices and past and present retail prices. On the other hand, the mathematical equation suggests that current retail prices are dependent on past farm gate prices and past and present retail prices.

Conclusions were made based on the results obtained from the tests taking into consideration the p-values and F-statistics. The results revealed four causality relationships among the variables. For example, if the following were the causality relationships tested between farm gate and retail prices;

i. A unidirectional causality from retail to farm gate levels exists if;

Σ i $\theta \neq 0$ and Σ I $\beta = 0$

ii. A unidirectional causality from farm gate to retail levels would be confirmed if,

Σ i $\theta = 0$ and Σ i $\beta \neq 0$

iii. A bidirectional causality is said to exist if both

Σ i $\theta \neq 0$ and Σ i $\beta \neq 0$

iv. An absence of a causal relationship between the variables, that is, independence would be concluded if both

Σ i $\theta = 0$ and Σ i $\beta = 0$

The VAR Lag Order Selection Criteria (VLOSC) was used to determine the optimal lag length of the formulated VAR models shown by the equations above. Schwarz Information Criterion (SIC), Final Prediction Error (FPE), Sequantial Modified LR test statistic, Hanna-Quinn Information Criterion (HQIC) and the Akaike Information Criterion (AIC) were the VLOSC measures used for indicating the goodness of fit alternative models.

3.3.5 Analysing price asymmetry

Price asymmetry was tested for the Co-integrated variables and non-Cointegrated variables were not tested for the price asymmetry. This was in accordance with the Granger Causality Test findings as well as the Johansen Co-integration Test results. Vector Error Correction model was employed on the co-integrated variables.

A. Farm-Retail Price transmission and Retail-Processor transmission

In order to determine whether retailers adjust to farm price and processor adjust to retail price which increases the same way they do to decreases, an Error Correction Model (ECM) was used. The VECM specification and estimation was done in compliance with the Engle and Granger (1987) two-step procedure in permutation with the error correction term splitting concept and VECM.

In Vector Error Correction Model estimation, the first step is to estimate the Co-integration regression with the use of OLS (Engle and Granger, 1987). With that being said, the Co-integration equation 4.11 and 4.12 had to be set up for the estimation.

$logRP_t = \emptyset + \varphi logFGP_t + u_t$ Equation 3.21

$logPP_t = \emptyset + \varphi logRP_t + u_t$ Equation 3.22

where; $logRPt$ is the natural logarithm of retail price in time (t)

$logFGPt$ is the natural logarithm of farm gate price in time (t)

$logPPt$ is the natural logarithm of processor price in time (t)

$\emptyset, \varphi$ are coefficients

t represents the error term

Once instituting the long run relationship between farm and retail prices as well as between retail and processor prices with the aid of equation 3.21 and 3.22, the Error Correction Model (ECM) specified in equation 4.13 and 4.14, were estimated using OLS.

$$\Delta logRP_t = \theta + \sum_{i=1}^{5} \gamma \Delta logRP_{t-i} + \sum_{j=1}^{5} \beta \Delta logFGP_{t-j} + \delta_2^+ ECT_{t-1}^+ + \delta_2^- ECT_{t-1}^- + u_t$$

Equation 3.23

$$\Delta logPP_t = \varepsilon + \sum_{i=1}^{5} \gamma \Delta logPP_{t-i} + \sum_{j=0}^{5} \beta \Delta logRP_{t-j} + ECT_{t-1}^+ + \delta_2^- ECT_{t-1}^- + u_t$$

Equation 3.24

Where; $\Delta logRP_t =$ first differenced log RP in period (t)

$\sum_{i=1}^{5} \gamma \Delta logRP_{t-i}$ = the 1st,2nd …5th lagged first differenced values of $log\ RP$

$\sum_{j=1}^{5} \beta \Delta logFGP_{t-j}$= the 1st,2nd …5th lagged first differenced values of $log\ FGP$ with its value in period (t)

$\Delta logPP_t =$ first differenced log PP in period (t)

$\sum_{i=1}^{5} \gamma \Delta logPP_{t-i}$= the 1st,2nd …5th lagged first differenced values of $log\ PP$

$\sum_{j=0}^{5} \gamma \Delta logRP_{t-j}$= the 1st,2nd …5th lagged first differenced values of $log\ RP$ with its value in period (t)

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

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

$\gamma, \theta, \beta, \delta_2^-, \delta_2^+ =$ Are the estimated coefficients

According to Vavra and Goodwin (2005), including the error correction terms in long run equilibrium allows the estimated price to respond to the changes in the explanatory price but also correct any deviations that may be left over from previous periods. The asymmetric price transmission is possible with the inclusion of positive and negative error correction terms. The error correction terms in equation 3.23 and 3.24 measure the deviations from the long run equilibrium of between farm gate prices with retail prices and between processor prices with retail prices.

3.4 Conclusion

The chapter gave a description of the study area, data collection information and the analytical methods applied to the study. The following chapter highlights the empirical results obtained from running the regressions and tests as specified in this chapter.

CHAPTER FOUR:
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the study. The analysis was based on 204 observations of farm gate, processor and retail prices of both cheese and pasteurised liquid milk. The data was extracted from DAFF, Stats SA and Milk Producers Organisation (MPO). The chapter is structured as follows: in the first section, the results of correlation coefficients are presented. The succeeding sections present results meeting objectives 2 and 3. First, the stationarity of the time-series price data is presented as obtained from the Augmented Dickey-Fuller and Phillips-Perron (PP) tests. The second step is the presentation of lag order selection results followed by Granger Causality Tests showing the direction of causality. The fourth step demonstrate the results of the co-integration test and lastly the results from VECM model.

4.2 Correlation analysis

Correlation is a statistical technique that is used to measure and describe the strength and direction of the relationship between two variables. Table 4.1 demonstrates correlation coefficients for milk produced and quantity of milk processed.

Table 4.1: Correlation matrix between milk produced and quantity of milk processed.

	MP	QMP
MP	1.0000	1.0000
QMP	1.0000	1.0000

Source: Author Computation, 2018

A correlation matrix was generated to get a brief look at the relationship between the milk produced and quantity of milk processed in South Africa as shown in table 4.1. It is evident that the QMP and MP have a perfect relationship, that is, they are linearly related and have correlation coefficients of 1. The relationship between the variables is positive as shown by the positive coefficient (+1). Thus, the QP and QMP move in one direction. These imply that if MP increases, QMP also increases and if MP decreases, QMP decreases. This generally makes sense because if the milk producers face a period of recession and produce less milk than they normally do, then they will have a little to sell to the processors for processing purposes thus the quantity of milk processed will also decrease as a result of decrease in milk production within the country.

4.3 Augmented Dickey-Fuller (ADF) and Phillips-Perron Unit Root Test

Table 4.2: Augmented Dickey-Fuller (ADF) Unit Root Testing Results for cheese and pasteurised liquid milk

Variables	ADF Statistic	P value at level	DW stat	ADF Statisctic 1st difference	P value at 1st difference	DW stat
FGPC	-0.500497	0.8873	2.078202	-14.76304	0.0000***	2.04
PPC	-1.814924	0.6941	1.716916	-12.31188	0.0000***	2.022057
RPC	-1.703563	0.4280	2.032042	-11.67128	0.0000***	2.024520
FGPPLM	0.252593	0.9752	2.011153	-6.043179	0.0000***	2.012092
PPPLM	-0.144791	0.9417	2.045387	-8.978774	0.0000***	2.048764
RPPLM	0.543754	0.9878	2.120090	-6.982334	0.0000***	2.119022

Source: Author computation, 2018

The test results are presented in Table 4.2. The unit root of the Farm gate, Processor and Retail prices for both Cheese and Pasteurised liquid milk were tested firstly using ADF procedure. Usman (2012) asserts that it is generally a good thing to start the general ADF model that contains both a constant and a trend. If a unit root is not rejected based on the general test form, one then proceeds with the tests without a time trend and a drift. This usually improves the efficiency and the power of the test. It is confirmed that both the trend and the drift are statistically insignificant based on the ADF t-statistics at the 5% significance level. Hence, the ADF test at the level is performed without a drift or time trend.

The ADF were done for all monthly price series covering the period from January 2000 to December 2016. From the Table 4.2, the Augmented Dickey Fuller test results for the unit root shown proves that, all variables had a unit root at level form. Hence, null hypothesis cannot be rejected at 1%, 5% and 10% levels of significance. This was due to the ADF test statistic values of the three prices for Cheese and pasteurised liquid milk shown to be greater than the Mackinnon critical values for rejecting the hypothesis of a unit root.

The Durban Watson Statistics are all significant enough to reject the presence of serial correlation in each of the series; hence the results are considered reliable and can be trusted. Thus, the farm gate, processor and retail prices of cheese and pasteurised liquid milk are non-stationary.

Vavra and Goodwin (2005) state that there is a need for the transformation of non-stationary economic time series data done through differencing or de-trending, otherwise the results 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 the data is used for analysis. Therefore, all variables were subjected to first difference, and they became stationary. The null hypothesis at first difference is rejected, indicating that there is no unit root.

Table 4.3: Phillips-Perron (PP) Unit Root Testing Results for cheese and pasteurised liquid milk

Variable	PP Statistic	P-value at level	PP Statistic at 1st difference	P-value at 1st difference
FGPC	-0.438480	0.8988	14.77536	0.0000
PPC	-0.889397	0.7901	-12.31188	0.0000
RPC	-1.709339	0.4250	-11.77283	0.0000
FGPPLM				0.0000
PPPLM	-0.064435	0.9505	8.978774	0.0000
RPPLM	-1.797899	0.7024	8.785388	0.0000

Source: Author's Computation, 2018

The Phillips-Perron unit root tests were performed to check the robustness of the findings concerning the price series at levels and first difference. Table 4.3 presents the results from the PP unit root tests of the variables.

Phillips-Perron tests revealed high P-values at the levels implying that the null hypothesis of non-stationarity cannot be rejected at any significance level. However, the series are stationary at 1st difference as shown by the lower P-values. The results were obtained from PP tests on the presence of unit roots in the level price series for both cheese and pasteurised liquid milk. The two tests reveal that none of the monthly prices is stationary at levels, that is, at any conventional critical values.

Since all variables are stationary at first difference, the variables are integrated of same order, which is order one. That being the case, the requirement for Johansen test of Co-integration has been satisfied. The Johansen test of Co-integration requires that variables be integrated of same order. Having satisfied such requirement, Johansen test of Co-integration will follow.

4.4 Lag order selection criteria

Lag order selection criteria was carried out in order to have a correct specification of the VAR model to use in Granger causality tests. Table 4.4 shows the results of the optimal lag length used in the causality tests. The results are between the farm gate, processor and retail prices of pasteurised liquid milk with 204 observations. Endogenous variables were the FGPPLM, PPPLM and RPPLM while the exogenous variable was C.

Table 4.4: Vector Auto Regressive lag order Selection Criteria for pasteurised liquid milk

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-52.86184	NA	0.000352	0.561426	0.611073	0.581519
1	843.9001	1757.473	4.69e-08	-8.360805	-8.162214	-8.280430
2	873.4098	56.94232	3.82e-08*	-8.566932*	-8.219398*	-8.426276*
3	879.4028	11.38381*	3.94e-08	-8.536712	-8.040234	-8.335774
4	881.8990	4.666175	4.20e-08	-8.471347	-7.825925	-8.210128
5	893.4599	21.26273*	4.10e-08	-8.497084	-7.702719	-8.175584

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error AIC: Akaike information criterion

SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Source: Author’s Computation, 2018

Based on the results as shown on the table; Final Prediction Error, Akaike Information Criterion, Schwarz Information Criterion and Hannan-Quinn Information Criterion chose lag two as the optimal lag length while sequential modified LR test statistic chose lag 3. Lag 2 was therefore chosen when running the Granger Causality Tests as it was chosen by HQ that gives viable results when the observations are more than 120 which is the case in this study because it has 204 observations. HQ results were supported by AIC, FPE and SIC results.

The same method was followed to determine the optimal lag length between farm gate, processor and retail prices cheese in South Africa. Results are shown in Table 4.5 for the sample with 204 observations from Jan 2000- Dec 2016, FGPPLM, PPPLM and RPPLM were the endogenous variables, while the constant C was the only exogenous variable.

Table 4.5: Vector Auto Regressive lag order Selection Criteria for cheese

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1459.143	NA	483.6095	14.69491	14.74456	14.71500
1	-336.2606	2200.613	0.006648	3.500167	3.698758*	3.580542*
2	-323.3024	25.01631	0.006389*	3.460326*	3.807861	3.600982
3	-316.8376	12.28004	0.006555	3.485805	3.982283	3.686742
4	-313.1141	6.960410	0.006914	3.538835	4.184257	3.800054
5	-303.4908	17.69914*	0.006874	3.532571	4.326936	3.854071

Source: Author's Computation, 2018

In Table 4.5, the character (*) indicates lag order selected by each criterion. The VAR lag order selection criteria results summarised in the table show that AIC and FPE chose 2 lags, SC and HQ 1 lag and only LR chose 5 lags. AIC is generally regarded as the best compared to others because it selects the true lags more frequently than the other criteria. As a result, two lags were used as the optimal lag length for testing Granger Causality relationships between farm gate prices, processor and retail prices as guided by AIC and FPE chosen lag length.

4.5 Results of the Granger-Causality Tests

4.5.1 Granger Causality Test results for cheese market

Table 4.6: Granger Causality Test Results for Cheese

	Cheese			
Null hypothesis	F statistic	Df (Lags)	Prob.	Decision
RP does not granger cause FGP	0.20025	2	0.8187	Do not reject
FGP does not granger cause RP	1.14364	2	0.3208	Do not reject
PP does not granger cause FGP	0.42526	2	0.6542	Do not reject
FGP does not granger cause PP	2.73468	2	0.0674	Do not reject
PP does not granger cause RP	1.02524	2	0.3606	Do not reject
RP does not granger cause PP	2.67715	2	0.0713	Do not reject

Source: Author's Computation, 2018

a. Price causality between Farm gate and retail

Table 4.6 shows both p-values (0.8187 and 0.3208) are insignificant at 5% level, as a result we accept the null hypothesis that farm gate prices (FGP) do not granger cause retail prices (RP) and retail prices not granger cause farm gate prices. The F-statistic probabilities, however, indicate a slight possibility of the hypothesis in FGP not causing RP more likely to be rejected at a higher significance level. There is therefore, a possibility that FGP may perhaps cause the RP than the opposite even though the chances are slight. The empirical evidence available at 5% level even so, still suggests that there is no prognostic power between farm gate prices and retail prices. There is an independent causal relationship between farm gate and retail prices. These results concur with Mandizvidza (2013)'s findings who also found an independent relationship between farm gate and retail.

b. Price causality between Farm gate and Processor

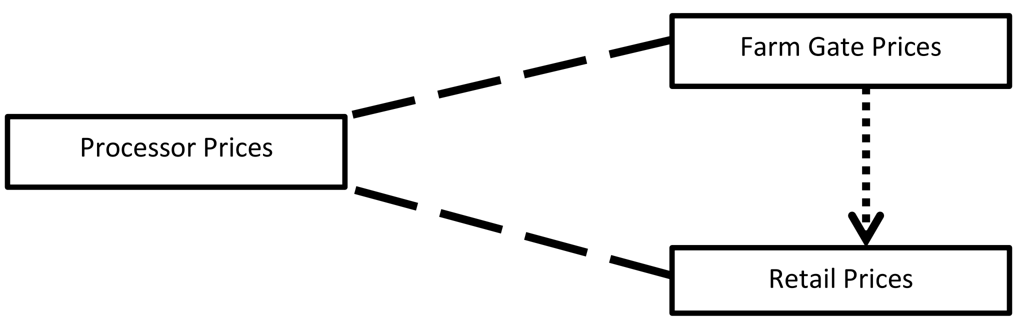
Price causality results between farm gate and processor revealed p values of 0.6542 and 0.0674 which are both greater than 0.05. These imply that the variables are statistically insignificant; therefore, the stated null hypotheses are accepted. With such statistical evidence, it is concluded that there exists no causal relationship between farm and processor.

c. Price causality between Retail and processor

Table 4.6 show the p-values (0.3606 and 0.0713) are both insignificant at 5% significance level. The null hypotheses stated are both rejected based on the p-values. Thus, retail prices do not granger cause processor prices and vice versa. A conclusion was made that the prices are not related. Therefore, processor prices are not useful in making predictions and forecasts of future prices at the retail level and vice versa.

The causal relationships given at table 4.6 indicate no causal relationship between the retail, processor and farm gate prices. That is, they do not depend on what happens at other marketing levels when forming their market expectations and determining prices. For example, the retail current prices cannot be explained by processor prices. Thus adding lagged prices of processor level cannot give more insights on retail prices. This lack of relationship can be caused by limited information in the cheese market, that is, the communication system used may not be sufficient.

Figure 4.1: Granger causality price direction



Source: Author's Computation, 2018

The dotted line represents the possibility for a causal relationship while the dashed lines represent no causal relationship. The figure gives evidence that there is no existence of causal relationship between farm gate and retail prices. Thus, retail and farm gate prices do not play a role in the process of formulating prices at the processor level. As a result, both the prices of farm gate and retail past and current price information are not useful in improving the forecasts of the processor prices. The farm gate and retail prices have a weak causal relationship as demonstrated on figure 4.1.

4.5.2 Granger Causality Test results for Pasteurised Liquid Milk

Table 4.7: Granger Causality Test Results for Pasteurised Liquid milk

	Pasteurised Liquid milk			
Null hypothesis	F statistic	Df (Lags)	Prob.	Decision
RP does not granger cause FGP	32.3021	2	7.E-13	Reject
FGP does not granger cause RP	2.14532	2	0.1198	Do not Reject
PP does not granger cause FGP	25.7228	2	1.E-10	Reject
FGP does not granger cause PP	8.88192	2	0.0002	Reject
PP does not granger cause RP	10.8181	2	3.E-05	Reject
RP does not granger cause PP	7.99268	2	0.0005	Reject

Source: Author's Computation, 2018

a. Price causality between Farm gate and retail

The p-value of 0.1198 is more than 5% so the null hypothesis cannot be rejected; the null hypothesis is accepted. Farm gate prices do not granger cause retail prices. Thus, the current and previous prices of the farm gate do not help in predicting the retail prices. On the other hand, the p-value of 7.E-13 is significant at 1% level and shows a causal relationship between RP and FGP. Therefore, RP granger causes FGP, thus the null hypothesis is rejected. It is evident from the results that there exists a unidirectional relationship between farm gate and retail prices as it moves one way from retails to farm gate. Mandizvidza (2013) emphasised that a unidirectional relationship is explained by high concentration and market power at the stage or level. Thus, retails are concentrated and have a market power as compared to processors. These findings are in contrast with findings elsewhere (Kirsten & Cutts, 2006; Uchezuba, 2010) who found a unidirectional relationship running from farm to retail. The findings in this study are explained by the high concentrated retailers selling pasteurised liquid milk in South Africa and the market power they have in price determination. Milk producers are forced to “price taking” behaviour in South Africa.

b. Price causality between processor and farm gate

As shown on the table, causal relationship was found between processor and farm gate. There is a bi-directional causal relationship between processor and farm gate. This is shown by the p-values of (1.E-10 and 0.0002) which are both significant at 5% level. The null hypothesis stated as PP does not granger cause FGP and FGP does not granger cause PP has been rejected. This implies that farm gate prices are helpful and are used when predicting the processor prices and vice versa.

c. Price causality between retail and processor

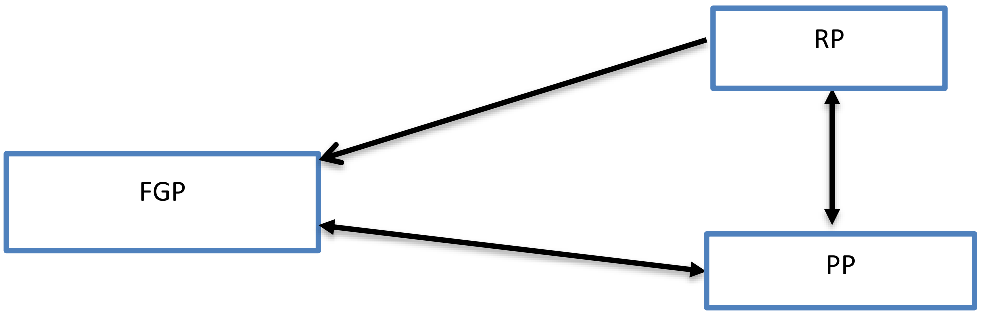
From the observation we reject both null hypotheses stated as PP does not granger cause RP and RP does not granger cause PP. This is because the probabilities are significant at 5% level with the p-values of 3.E-05 and 0.0005 respectively. It is known that if hypothesis $H0^1$ and $H0^2$ are both accepted, there exists a bidirectional relationship, thus linear causality runs in two ways. Thus, processor prices are used when forecasting retail prices and retail prices depend on processor historic and present prices.

Table 4.7 revealed that there is a bidirectional relationship between retail and processor and processor and farm gate prices. This implies that they impact each other, the impact can be positive for both variables, negative for both, or positive for one and negative for one. The prices depend on each other in making predictions and providing market insights at that level. The relationship is going in two ways meaning that if farm gate prices increase, it will trigger the prices at the other value chain levels even if it starts at the retail it will trigger at the farm gate and processor levels.

FGP ⟹ PP ⟹ RP   RP ⟹ PP ⟹ FGP

This clearly indicates that prices of pasteurised liquid milk are determined at every level. That is, the processors, retailers and producers are working together in forming prices or they may be copying what is implemented at other marketing levels. For example, if prices are increased at farm gate level because of increased input costs then the processors and retailers are likely to follow the price increase. This can be due to the nature of the pasteurised liquid milk which unlike cheese does not have a long shelf life so working together of the marketing participants (retailers, processors and farmers) helps them in selling the product and avoid having spoilt milk on them.

Figure 4. 2: Granger causality direction



Source: Author's Computation, 2018

The solid lines represent the causal relationship between the variables. The two arrows indicate a bidirectional relationship and one arrow indicates a unidirectional relationship. The figure indicates that FGP and PP as well as PP and RP have a bidirectional causal relationship. That is, the FGP plays an important role in determining the prices at processor level and vice versa. These imply that in determining the FGP, historical and recent prices of processor have to be taken into account. The same is seen for PP and RP. On the other hand, the confirmation of a unidirectional relationship is seen from RP to FGP. The past and present prices of retailers help in formulating farm gate prices.

4.6 Test for price Asymmetry

This section aims at checking whether changes in prices at the farm gate level are transmitted symmetrically or asymmetrically to processor and retail stages in the dairy industry in South Africa. A Johansen test was carried out and the results are presented in Table 4.8.

Table 4.8: Johansen Co-integration Rank Test Results (Trace & Max-Eigen value statistic) for cheese market

Series	Hypothesised No. of CE(s)	Trace Statistic	0.05 Critical values	Prob*	Max-Eigen Statistic	0.05 Critical values	Prob*
FGPC, PPC and RPC	None	18.46950	29.79707	0.5315	14.79164	21.13162	0.3037
	At most 1	3.677863	15.49471	0.9278	3.520744	14.26460	0.9062
	At most 2	0.157119	3.841466	0.6918	0.157119	3.841466	0.6918
*denotes rejection of the hypothesis at the 0.05 level ** Mackinnan-Haug-Michelis P values (as reported by EViews) Trace test indicates r co-integrating model (s) at 5% significance level							

Source: Author's Computation, 2018

4.6.1 Cheese market

Table 4.8 shows the trace statistic which is less than the critical value. It then fails to reject the null hypothesis at 5% level. The findings confirm that FGP, PP, and RP of cheese are not co-integrated. This is seen by the probability of 0.3037 that is more than 5% significant level. Price transmission can now be analysed using the Houck procedure at these three levels. The Houck procedure aims at finding out whether unit increases in farm gate, processor and retail price from period to period had a different absolute impact than unit decrease. However, this study did not go deeper into analysing price transmission of the non-Co-intergrated variables.

Table 4.9: Johansen Co-integration Rank Test Results (Trace & Max-Eigen value statistic) for pasteurised liquid milk market

Series	Hypothesised No. of CE(s)	Trace Statistic	0.05 Critical values	Prob*	Max-Eigen Statistic	0.05 Critical values	Prob*
FGPPLM, PPPLM and RPPLM	None	72.60928	29.79707	0.0000*	51.37560	21.13162	0.0000*
	At most 1	21.23369	15.49471	0.0061*	21.19670	14.26460	0.0034*
	At most 2	0.036988	3.841466	0.8475	0.36988	3.841466	0.8475
*denotes rejection of the hypothesis at the 0.05 level ** Mackinnan-Haug-Michelis P values (as reported by EViews) Trace test indicates r co-integrating model (s) at 5% significance level							

Source: Author's Computation, 2018

4.6.2 Pasteurised liquid milk

Based on the Johansen Test shown in table 4.9, variables FGP, PP and RP are co-integrated. Co-integration analysis discovered two co-integrating vectors in the relationship analysed. The null hypothesis of no co-integration between FGP, PP and RP is rejected. The rejection is due to significance of p-values at 1% level. There is therefore, an existence of a long run co-integration relationship between the variables. Price transmission can now be analysed using the VECM model.

Table 4.10: Farm gate to processor co-integration test

Series	Hypothesised No. of CE(s)	Trace Statistic	0.05 Critical values	Prob*	Max-Eigen Statistic	0.05 Critical values	Prob*
FGPPLM and PPPLM	None*	15.91909	15.49471	0.0431	15.88783	14.26460	0.0275
	At most 1	0.031267	3.841466	0.8596	0.031267	3.841466	0.8596
*denotes rejection of the hypothesis at the 0.05 level ** Mackinnan-Haug-Michelis P values (as reported by EViews) Trace test indicates r co-integrating model (s) at 5% significance level							

Source: Author's computation, 2018

The trace test fails to reject at most one co-integration model (CE) at 5% significance level, thus, there is a long run relationship between the farm gate and processor prices.

Table 4.11: Farm gate and retail co-integration

Series	Hypothesised No. of CE(s)	Trace Statistic	0.05 Critical values	Prob*	Max-Eigen Statistic	0.05 Critical values	Prob*
FGPPLM and RPPLM	None*	17.92075	15.49471	0.0211	17.87743	14.26460	0.0129
	At most 1	0.043316	3.841466	0.8351	0.043316	3.841466	0.8351
*denotes rejection of the hypothesis at the 0.05 level ** Mackinnan-Haug-Michelis P values (as reported by EViews) Trace test and Max-Eigen value test indicates r co-integrating model (s) at 5% significance level							

Source: Author's Computation, 2018

The hypothesis of a non co-integration relationship existing between farm prices and retail prices is rejected. The decision was based on the p value which is significant at 5% level, therefore it can be confirmed that there is a long run relationship between farm gate and retail prices in the pasteurised liquid milk.

4.7 Vector error correction model results

Table 4.12: Farm gate and retail VECM

	Coefficient	Std. Error	t-Statistic	Prob.
ECT_{t-1}	-0.058961	0.032291	-1.825927	0.0694*
*log*FGPPLM$_{(-1)}$	0.251360	0.082941	3.030607	0.0028***
*log*FGPPLM$_{(-2)}$	0.204563	0.083718	2.443482	0.0154**
*log*RPPLM$_{(-1)}$	0.264043	0.071241	3.706322	0.0003***
*log*RPPLM$_{(-2)}$	-0.126044	0.072403	-1.740877	0.0833*
CONSTANT	0.004484	0.004472	1.002669	0.3173
F-statistic	14.16013			
Prob(F-statistic)	0.000000			

Source: Author’s Computation, 2018

The error correction term in Table 4.2 has a negative coefficient and it is significant at 10% level of significance. This implies that the system will revert into equilibrium in a short run and the long run disequilibrium will be corrected in a short run. The speed of adjustment is 5.8%.

Table 4.13: VECM between farm gate and processor

	Coefficient	Std. Error	t-Statistic	Prob.
ECT_{t-1}	-0.046048	0.023450	-1.963645	0.0510*
*log*FGPPLM(-1)	0.405639	0.071641	5.662132	0.0000***
*log*FGPPLM(-2)	0.128088	0.073920	1.732797	0.0847*
*log*PPPLM(-1)	0.088559	0.026207	3.379190	0.0009***
*log*PPPLM(-2)	-0.018078	0.026929	-0.671328	0.5028
CONSTANT	0.004258	0.004363	0.976027	0.3303
F-statistic 13.83173 Prob (F-statistic) 0.000000				

Source: Author Computation, 2018

Error correction term is negative and significant meaning that there is an existence of a long run relationship between farm gate and processor prices of pasteurised liquid milk. Error correction term is significant at 10% level with p-value of (0.0510) and it is complemented by the negative coefficient of the error term. It can now be concluded that the system will be able to revert into equilibrium in a short run.

Table 4.12 and 4.13 give evidence of asymmetric price transmission between farm gate and retail as well as farm gate and processor levels. According to DairyCO (2010), prices are said to be asymmetric if they move in the same direction but not at the same time. The prices here move in the same direction but not at the same time as revealed by the results. The speed of adjustments in both cases implies that the prices can revert to equilibrium by 5.8% and 4.6% every month respectively. This proves and clearly indicates that when prices at farm gate level increases, the retailers and processor react to them but not very fast. This behaviour can be explained by the low shelf life of pasteurised liquid milk which if they react quickly to price increases they might remain with rotten products on their shelves. The results were expected since it is common in the real world that if prices of inputs increase it triggers the output prices. The same is seen with suppliers and final retailers since if the supplier prices increase, the final retailer also increases prices in order to make profits. These results concur with other studies

(Mandizvidza, 2013; Uchezuba 2010; Kirsten and Cutts, 2006) who argued that the asymmetric price transmission can change because the retailers and processors are profit oriented so they react to any situation that seems to be threatening their profits. Thus they react when their profits are squeezed than when they are stretched.

Meyer and Von Cramon-Taubadel (2004) state that 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. Therefore, this study followed and satisfied this method since the speed of adjustment were found.

4.8 Conclusion

This chapter has detailed the empirical results obtained from the monthly data for the period 2000 to 2016. Results obtained from the analysis are as expected for the relationship between milk production and milk processed. Evidence of asymmetric price transmission in Pasteurised liquid milk was revealed while Cheese shows a non-Co-integrated relationship. The results also match well with those obtained in the literature on similar studies on price transmission analysis.

CHAPTER FIVE:
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarises the main findings of the study, concludes on the basis of the findings derived from the empirical results and generates the recommendations as guided by the results of the study. Lastly, it offers ideas on areas for further research.

5.2 Summary

This study was aimed at investigating and analysing the nature of price transmission mechanism of pasteurised liquid milk and cheese in South Africa from 2000 to 2016. The first objective was to determine the correlation between the milk production and quantity of milk processed in South Africa. The second objective was to determine the direction of causality between the farm gate, processor and retail prices of cheese and pasteurised liquid milk in South Africa and lastly, the third objective was to determine whether the price transmission of pasteurised liquid milk and cheese was symmetric or asymmetric in South Africa from 2000 to 2016.

The research hypotheses of the study were stated as follows: there is no correlation between the milk production and quantity of milk processed in South Africa; there is no causal relationship between the farm gate, processor and retail prices of cheese and pasteurised liquid milk in South Africa and finally, the price transmission of cheese and pasteurised liquid milk in South Africa is neither symmetric nor asymmetric. The study period was 17 years.

Theoretical and empirical literature was reviewed in chapter two were key words were defined, described and discussed in section two of the chapter. A thorough explanation was given, drawn from previous studies and findings of related studies were presented in section three.

The study used secondary time series data extracted from DAFF, MPO and Stats SA. The data was monthly and annually with 204 and 17 observations respectively from 2000 to 2016. The study applied Pearson Correlation Coefficient and Granger Causality Model to analyse the correlation between milk produced and quantity of milk processed and to check the direction of causality for pasteurised liquid milk and cheese value chain in South Africa respectively. VECM was used to analyse price transmission between the marketing levels of pasteurised liquid.

The study attempted to fill the information gap and provide clear insights into the market efficiency issues in the cheese and pasteurised liquid milk in South Africa by examining price linkages amongst marketing levels. Recapitulated below are the main findings of the study:

Milk produced has a perfect relationship and is linearly related with a coefficient of +1. This indicates that milk produced and quantity of milk processed move in one direction. ADF and PP results for farm gate, processor and retail prices were found to be stationary at first difference for both cheese and pasteurised liquid milk.

The optimal lag length tests generally chose two lags for both cheese and pasteurised liquid milk, as such 2 lags were used in running the Granger causality tests and VECM in the study.

The results of the Pair-Wise Granger Causality Tests for cheese suggested that there is no causal relationship though signs of independent causal relationship from farm gate to retail prices were revealed. Thus, there is an existence of a weak relationship between the two marketing levels. No causal relationship from farm gate to processor and retail to processor was found.

The Pair-Wise Granger Causality Test results for pasteurised liquid milk suggested a bidirectional causal relationship between processor and farm gate prices and also between retail and processor prices. On the other hand, unidirectional causality was found from retail to farm gate prices.

There was no evidence of a long run relationship in the cheese market as proved by Johansen Co-integration Test. However, a long run relationship was found on pasteurised liquid milk marketing levels. Thus, the VECM was run for pasteurised liquid milk. The VECM found asymmetry in price transmission between farm gate and retail prices and also between farm gate and processor prices. This necessitates that retailers and processor react quicker to farm gate price increases than they do to price decreases.

5.3 Conclusion

The primary purpose of the study was to provide information on price transmission mechanism of the cheese and pasteurised liquid milk market. The first hypothesis stated was: there is no correlation between milk produced and quantity of milk processed was rejected. The second hypothesis was that there is no causal relationship between farm gate, processor and retail prices for both cheese and pasteurised liquid milk in South Africa and it was rejected based on the findings of the study. The last hypothesis was also rejected as it depicted that the price transmission mechanism of cheese and pasteurised liquid milk is neither symmetric nor asymmetric and the findings confirmed asymmetry in pasteurised liquid milk. It is however, accepted for cheese since the price transmission is neither symmetric nor asymmetric.

Based on the results of the study, it is concluded that there is an existence of a huge gap between what consumers are paying at retailers when buying pasteurised liquid milk and what the farmers actually receive in South Africa.

Guvheya et al., (1998) note that 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. Thus, the causal relationship results are imperative in drawing conclusions. The causal relationship between farm gate, processor and retail prices for cheese suggests that prices may be determined at farm gate and transferred to processors and retailers. On the other hand, prices are determined at all levels for pasteurised liquid milk. It is transferred from farm gate to processor, processor to retail and back to farm gate from the retails.

The price transmission of pasteurised liquid milk is asymmetric between farm gate and also between farm gate and processor levels.

5.4 Recommendations

The study recommends that: investment be made in dairy farming in South Africa by offering or providing emerging farmers with subsidies, grants and education on modern production methods and technology in order to increase the production. This will trigger the quantity of milk processed in the country since the Pearson correlation findings of the study indicated that as milk produced increases, milk processed also increases. Thus, the country will eventually be self-sustained in the dairy industry. This will not only benefit the domestic milk producers but also the consumers since they will buy the dairy products at affordable prices.

The study found that retailers and processors are quick to react to farm gate price increase thus they quickly adjust their prices in order to pass the price increase to the consumers. However, the same is not done when the prices decrease at the farm gate level thus the retailers and processors are benefiting at the cost of the consumers. This situation implies that consumers are being exploited when prices increase but they do not enjoy the rewards of the price decrease. In light of this, the study recommends that the government of South Africa implement policies to protect the consumers against this behaviour. The Department of Consumer Affairs must implement a price-monitoring cell where they take care of these issues.

The activities of the cell must include monitoring of the retail and processor prices, and track future prices of cheese and pasteurised liquid milk on a daily basis. The Price Monitoring Cell will analyse the price situation in the industry and give feedback in advance, affording the department ample time to apply preventive measures which would help policy interventions at an appropriate time to prevent undesired behaviour from the retailers to the consumers.

5.5 Area for further research

The study established that there is an existence of price asymmetry in pasteurised liquid milk and assumed the causes of the nature of price transmission. Thus, it is recommended that further research be conducted investigating and analysing the factors influencing the asymmetric price transmission in South Africa. Such complementary studies will help in justifying and supporting the results of this study and will provide more information on how the dairy industry operates.

The cheese market was found lacking a long run relationship and this study did not go any further. Therefore, it is recommended that further research be conducted using the Houck approach to find out if the price transmission is symmetric or asymmetric for cheese marketing levels.

This study only focused on two dairy products, which are cheese and pasteurised liquid milk. There is therefore, a need for price transmission studies on all dairy products in South Africa. In this way, the information gap will be closed.

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APPENDICES

Appendix 7.1: Results of correlation matrix between milk produced and quantity of milk processed

	MP	QMP
MP	1.000000	1.000000
QMP	1.000000	1.000000

Appendix 7.2: Results of Vector Auto Regressive lag order selection for pasteurised liquid milk

VAR Lag Order Selection Criteria
Endogenous variables: FGPPLM PPPLM RPPLM
Exogenous variables: C
Date: 11/23/17 Time: 15:06
Sample: 2000M01 2016M12
Included observations: 199

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-52.86184	NA	0.000352	0.561426	0.611073	0.581519
1	843.9001	1757.473	4.69e-08	-8.360805	-8.162214	-8.280430
2	873.4098	56.94323	3.82e-08*	-8.566932*	-8.219398*	-8.426276*
3	879.4028	11.38381	3.94e-08	-8.536712	-8.040234	-8.335774
4	881.8990	4.666175	4.20e-08	-8.471347	-7.825925	-8.210128
5	893.4599	21.26273*	4.10e-08	-8.497084	-7.702719	-8.175584

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 7.3: Results for farm gate and processor cointegration test

Date: 11/23/17 Time: 15:40
Sample (adjusted): 2000M06 2016M12
Included observations: 199 after adjustments
Trend assumption: Linear deterministic trend
Series: PPPLM FGPPLM
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.076734	15.91909	15.49471	0.0431
At most 1	0.000157	0.031267	3.841466	0.8596

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.076734	15.88783	14.26460	0.0275
At most 1	0.000157	0.031267	3.841466	0.8596

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

PPPLM	FGPPLM
-2.224935	6.935511
0.965783	-1.861538

Unrestricted Adjustment Coefficients (alpha):

D(PPPLM)	0.035046	0.000594
D(FGPPLM)	-0.003589	0.000629

1 Cointegrating Equation(s): Log likelihood 431.7307

Normalized cointegrating coefficients (standard error in parentheses)

PPPLM	FGPPLM
1.000000	-3.117174
	(0.11952)

Adjustment coefficients (standard error in parentheses)

D(PPPLM)	-0.077976
	(0.02111)
D(FGPPLM)	0.007984
	(0.00837)

Appendix 7.4: Results for farmgate and retail co-integration test

Date: 11/23/17 Time: 15:42
Sample (adjusted): 2000M06 2016M12
Included observations: 199 after adjustments
Trend assumption: Linear deterministic trend
Series: FGPPLM RPPLM
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.085919	17.92075	15.49471	0.0211
At most 1	0.000218	0.043316	3.841466	0.8351

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.085919	17.87743	14.26460	0.0129
At most 1	0.000218	0.043316	3.841466	0.8351

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

FGPPLM	RPPLM
-9.391951	4.570964
-2.921959	1.983351

Unrestricted Adjustment Coefficients (alpha):

D(FGPPLM)	0.003067	0.000746
D(RPPLM)	-0.012055	0.000633

1 Cointegrating Equation(s): Log likelihood 634.2328

Normalized cointegrating coefficients (standard error in parentheses)

FGPPLM	RPPLM
1.000000	-0.486690
	(0.01354)

Adjustment coefficients (standard error in parentheses)

D(FGPPLM)	-0.028808
	(0.03522)
D(RPPLM)	0.113219
	(0.03975)

Appendix 7.5: Results for Vector Error Correction model between Farm gate and retail

Dependent Variable: D(FGPPLM)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 11/23/17 Time: 15:49
Sample (adjusted): 2000M04 2016M12
Included observations: 201 after adjustments
D(FGPPLM) = C(1)*(FGPPLM(-1) - 0.491244349141*RPPLM(-1) -
0.23622171332) + C(2)*D(FGPPLM(-1)) + C(3)*D(FGPPLM(-2)) + C(4)
*D(RPPLM(-1)) + C(5)*D(RPPLM(-2)) + C(6)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.058961	0.032291	-1.825927	0.0694
C(2)	0.251360	0.082941	3.030607	0.0028
C(3)	0.204563	0.083718	2.443482	0.0154
C(4)	0.264043	0.071241	3.706322	0.0003
C(5)	-0.126044	0.072403	-1.740877	0.0833

C(6)	0.004484	0.004472	1.002669	0.3173

R-squared	0.266367	Mean dependent var	0.017065
Adjusted R-squared	0.247556	S.D. dependent var	0.060884
S.E. of regression	0.052813	Akaike info criterion	-3.014731
Sum squared resid	0.543892	Schwarz criterion	-2.916125
Log likelihood	308.9805	Hannan-Quinn criter.	-2.974831
F-statistic	14.16013	Durbin-Watson stat	1.998082
Prob(F-statistic)	0.000000		

Appendix 7.6: Results for Vector Error Correction model between farm gate and processor

Dependent Variable: D(FGPPLM)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 11/23/17 Time: 15:53
Sample (adjusted): 2000M04 2016M12
Included observations: 201 after adjustments
D(FGPPLM) = C(1)*(FGPPLM(-1) - 0.323854381066*PPPLM(-1) -
0.324604285929) + C(2)*D(FGPPLM(-1)) + C(3)*D(FGPPLM(-2)) +
C(4)*D(PPPLM(-1)) + C(5)*D(PPPLM(-2)) + C(6)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.046048	0.023450	-1.963645	0.0510
C(2)	0.405639	0.071641	5.662132	0.0000
C(3)	0.128088	0.073920	1.732797	0.0847
C(4)	0.088559	0.026207	3.379190	0.0009
C(5)	-0.018078	0.026929	-0.671328	0.5028
C(6)	0.004258	0.004363	0.976027	0.3303

R-squared	0.261807	Mean dependent var	0.017065
Adjusted R-squared	0.242879	S.D. dependent var	0.060884
S.E. of regression	0.052977	Akaike info criterion	-3.008535
Sum squared resid	0.547273	Schwarz criterion	-2.909929
Log likelihood	308.3577	Hannan-Quinn criter.	-2.968634
F-statistic	13.83173	Durbin-Watson stat	1.995399
Prob(F-statistic)	0.000000		

Appendix 7.7: Descriptive statistics results

Mean	2.753676	7.503431	5.126103
Median	2.850000	8.055000	5.535000
Maximum	4.700000	13.51000	9.105000
Minimum	1.230000	3.130000	2.190000
Std. Dev.	1.023921	2.968821	1.986010
Skewness	0.303985	0.318427	0.309762
Kurtosis	1.857607	1.936528	1.907940
Jarque-Bera	14.23487	13.06073	13.39946
Probability	0.000811	0.001458	0.001231
Sum	561.7500	1530.700	1045.725
Sum Sq. Dev.	212.8279	1789.221	800.6801

Observations	204	204	204

Appendix7.8: Results for Vector Auto Regressive Lag length criteria test for Cheese

VAR Lag Order Selection Criteria
Endogenous variables: FGPC PPC RPC
Exogenous variables: C
Date: 11/24/17 Time: 17:31
Sample: 2000M01 2016M12
Included observations: 199

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1459.143	NA	483.6095	14.69491	14.74456	14.71500
1	-336.2666	2200.613	0.006648	3.500167	3.698758*	3.580542*
2	-323.3024	25.01631	0.006389*	3.460326*	3.807861	3.600982
3	-316.8376	12.28004	0.006555	3.485805	3.982283	3.686742
4	-313.1141	6.960410	0.006914	3.538835	4.184257	3.800054
5	-303.4908	17.69914*	0.006874	3.532571	4.326936	3.854071

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 7. 9: Results for Johansen Co-integration test for pasteurised liquid milk

Date: 11/18/17 Time: 15:42
Sample (adjusted): 2000M05 2016M12
Included observations: 200 after adjustments
Trend assumption: Linear deterministic trend
Series: PASTEURISED_LIQUID_MI01 PASTEURISED_LIQUID_MI02 PASTEURISED_LIQUID_MILK_
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.226537	72.60928	29.79707	0.0000
At most 1 *	0.100561	21.23369	15.49471	0.0061
At most 2	0.000185	0.036988	3.841466	0.8475

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.226537	51.37560	21.13162	0.0000
At most 1 *	0.100561	21.19670	14.26460	0.0034
At most 2	0.000185	0.036988	3.841466	0.8475

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

PASTEURISED_ LIQUID_MI01	PASTEURISED_ LIQUID_MI02	PASTEURISED_ LIQUID_MILK_
31.59498	-64.55303	34.05471
-0.162607	4.861751	-9.372869
0.472025	0.544031	-1.452037

Unrestricted Adjustment Coefficients (alpha):

D(PASTEURISED_LIQUID_MI01)	-0.017491	-0.036330	0.000825
D(PASTEURISED_LIQUID_MI02)	0.009663	-0.010406	0.000623
D(PASTEURISED_LIQUID_MILK_)	0.003627	0.006179	0.000650

1 Cointegrating Equation(s): Log likelihood 877.0890

Normalized cointegrating coefficients (standard error in parentheses)

PASTEURISED_ LIQUID_MI01	PASTEURISED_ LIQUID_MI02	PASTEURISED_ LIQUID_MILK_
1.000000	-2.043142	1.077852
	(0.02031)	(0.04001)

Adjustment coefficients (standard error in parentheses)

D(PASTEURISED_LIQUID_MI01)	-0.552626
	(0.30703)
D(PASTEURISED_LIQUID_MI02)	0.305298
	(0.13590)
D(PASTEURISED_LIQUID_MILK_)	0.114582
	(0.11956)

2 Cointegrating Equation(s): Log likelihood 887.6874

Normalized cointegrating coefficients (standard error in parentheses)

PASTEURISED_ LIQUID_MI01	PASTEURISED_ LIQUID_MI02	PASTEURISED_ LIQUID_MILK_
1.000000	0.000000	-3.070932
		(0.10272)
0.000000	1.000000	-2.030590
		(0.05022)

Adjustment coefficients (standard error in parentheses)

D(PASTEURISED_LIQUID_MI01)	-0.546718	0.952464
	(0.29546)	(0.60537)
D(PASTEURISED_LIQUID_MI02)	0.306990	-0.674357
	(0.13378)	(0.27410)
D(PASTEURISED_LIQUID_MILK_)	0.113577	-0.204069
	(0.11872)	(0.24324)

Appendix 7.10: Results for Johansen Co-integration test for cheese

Date: 11/18/17 Time: 15:43
Sample (adjusted): 2000M05 2016M12
Included observations: 200 after adjustments
Trend assumption: Linear deterministic trend
Series: CHEESE_PRICES_PER_KG_PRO CHEESE_PRICES_PER_KG_RET CHEESE_PROCESSOR_PRICE
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.071289	18.46950	29.79707	0.5315
At most 1	0.017450	3.677863	15.49471	0.9278
At most 2	0.000785	0.157119	3.841466	0.6918

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.071289	14.79164	21.13162	0.3037
At most 1	0.017450	3.520744	14.26460	0.9062
At most 2	0.000785	0.157119	3.841466	0.6918

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

CHEESE_PRICES_PER_KG_PRO	CHEESE_PRICES_PER_KG_RET	CHEESE_PROCESSOR_PRICE
-1.383775	-0.742100	2.683728
0.625674	0.524115	-1.411223
0.241914	0.265030	-0.816813

Unrestricted Adjustment Coefficients (alpha):

D(CHEESE_PRICES_PER_KG_PRO)	0.182652	-0.075637	-0.010569
D(CHEESE_PRICES_PER_KG_RET)	-0.226749	-0.252424	0.007700
D(CHEESE_PROCESSOR_PRICE)	-0.017434	-0.109385	-0.001926

1 Cointegrating Equation(s):	Log likelihood	-315.0790

Normalized cointegrating coefficients (standard error in parentheses)

CHEESE_PRICES_PER_KG_PRO	CHEESE_PRICES_PER_KG_RET	CHEESE_PROCESSOR_PRICE
1.000000	0.536287	-1.939425
	(0.03991)	(0.07142)

Adjustment coefficients (standard error in parentheses)

D(CHEESE_PRICES_PER_KG_PRO)	-0.252750
	(0.09574)
D(CHEESE_PRICES_PER_KG_RET)	0.313769
	(0.21106)
D(CHEESE_PROCESSOR_PRICE)	0.024125
	(0.08387)

Appendix 7.11 : Pair wise granger causality test results for Cheese

2 Cointegrating Equation(s):	Log likelihood	-313.3186

Normalized cointegrating coefficients (standard error in parentheses)

CHEESE_PRICES_PER_KG_PRO	CHEESE_PRICES_PER_KG_RET	CHEESE_PROCESSOR_PRICE
1.000000	0.000000	-1.376971
		(0.27205)
0.000000	1.000000	-1.048794
		(0.49156)

Adjustment coefficients (standard error in parentheses)

D(CHEESE_PRICES_PER_KG_PRO)	-0.300074	-0.175189
	(0.10474)	(0.06266)
D(CHEESE_PRICES_PER_KG_RET)	0.155834	0.035971
	(0.22995)	(0.13756)
D(CHEESE_PROCESSOR_PRICE)	-0.044314	-0.044392
	(0.09125)	(0.05459)

Pairwise Granger Causality Tests			
Date: 11/18/17 Time: 15:54			
Sample: 2000M01 2016M12			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
RP does not Gran ger Cause FGP	202	0.20025	0.8187
FGP does not Granger Cause RP		1.14364	0.3208
PP does not Granger Cause FGP	202	0.42526	0.6542
FGP does not Granger Cause PP		2.73468	0.0674
PP does not Granger Cause RP	202	1.02524	0.3606
RP does not Granger Cause PP		2.67715	0.0713

Appendix 7. 12: Pair wise granger causality test results for Pasteurised liquid milk

Pairwise Granger Causality Tests
Date: 11/18/17 Time: 15:57
Sample: 2000M01 2016M12
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
RP does not Granger Cause FGP	202	32.3021	7.E-13
FGP does not Granger Cause RP		2.14532	0.1198
PP does not Granger Cause FGP	202	25.7228	1.E-10
FGP does not Granger Cause PP		8.88192	0.0002
PP does not Granger Cause RP	202	10.8181	3.E-05
RP does not Granger Cause PP		7.99268	0.0005

Appendix 7.13: Results for Phillips Peron test

Null Hypothesis: CHEESE_PRICES_PER_KG_PRO has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.438480	0.8988
Test critical values:	1% level	-3.462574	
	5% level	-2.875608	
	10% level	-2.574346	

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

Residual variance (no correction)	0.957325
HAC corrected variance (Bartlett kernel)	0.874647

Phillips-Perron Test Equation
Dependent Variable: D(CHEESE_PRICES_PER_KG_PRO)
Method: Least Squares
Date: 11/18/17 Time: 16:06
Sample (adjusted): 2000M02 2016M12
Included observations: 203 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

CHEESE_PRICES_PER_KG_PRO(-1)	-0.004670	0.009330	-0.500497	0.6173
C	0.358244	0.416128	0.860898	0.3903

R-squared	0.001245	Mean dependent var	0.152857
Adjusted R-squared	-0.003724	S.D. dependent var	0.981460
S.E. of regression	0.983286	Akaike info criterion	2.813969
Sum squared resid	194.3370	Schwarz criterion	2.846611
Log likelihood	-283.6179	Hannan-Quinn criter.	2.827175
F-statistic	0.250498	Durbin-Watson stat	2.078202
Prob(F-statistic)	0.617273		

Null Hypothesis: CHEESE_PRICES_PER_KG_PRO has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.772880	0.7144
Test critical values:	1% level	-4.003902	
	5% level	-3.432115	
	10% level	-3.139793	

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

Residual variance (no correction)	0.943360
HAC corrected variance (Bartlett kernel)	0.958260

Phillips-Perron Test Equation
Dependent Variable: D(CHEESE_PRICES_PER_KG_PRO)
Method: Least Squares
Date: 11/18/17 Time: 16:07
Sample (adjusted): 2000M02 2016M12
Included observations: 203 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CHEESE_PRICES_PER_KG_PRO(-1)	-0.034715	0.019777	-1.755356	0.0807
C	1.241669	0.659618	1.882405	0.0612
@TREND("2000M01")	0.004295	0.002496	1.720646	0.0869

R-squared	0.015814	Mean dependent var	0.152857
Adjusted R-squared	0.005972	S.D. dependent var	0.981460
S.E. of regression	0.978525	Akaike info criterion	2.809127
Sum squared resid	191.5021	Schwarz criterion	2.858090
Log likelihood	-282.1264	Hannan-Quinn criter.	2.828935
F-statistic	1.606782	Durbin-Watson stat	2.046519
Prob(F-statistic)	0.203110		