AN ECONOMETRIC ANALYSIS ON THE ECONOMIC IMPACTS OF OIL PRICE FLUCTUATIONS IN SOUTH AFRICA

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Dissertation submitted in fulfilment of the requirements for the degree Masters of Commerce in Economics at the (Mafikeng Campus) of the North-West University

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November 2014

DECLARATION

I declare that *an econometric analysis to the economic impacts of oil price fluctuations in South Africa from 1990-2013* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Full names.. Date.................................

Signed...

Signature.. Date.................................
Supervisor

ACKNOWLEDGEMENTS

My greatest debt of gratitude is to my supervisor, Dr. Itumeleng Mongale, for his enthusiasm, encouragement and invaluable advice throughout the course of my masters' program. This research would not have been possible without his guidance.

I would also like to extend my heartfelt appreciation to my family for their unrelenting support and encouragement during the course of my studies. Without their being and character, even when it seemed the journey was far too long, this study could have been difficult to accomplish.

Finally, I would like to thank all those whose direct and indirect advice helped me to complete this dissertation.

ABSTRACT

Oil price fluctuation is a cause of concern for most of the economies of the world including South Africa. The premise is that since oil consumption is regarded as one of the major determinants of the economic activities in any country, therefore the price fluctuations have a potential of slowing down the economic growth in most countries. The purpose of the study is to analyse the impact of oil prices on economic growth in South Africa. With less attention to the emerging ones, this study attempts to take advantage of this research gap in order to extend the existing literature in the South African context. Determining such a relationship will not only be helpful to the academic community, but also to the policy makers and the international community. The study utilises secondary data to examine quarterly time series data from the year 1990Q1-2014Q1. Several sources of data (websites) like SARB, Qantec, and International Monetary Funds (IMF), among others, were considered to find the most relevant data for this study. The model of this study was estimated by using a cointegrating vector autoregressive (CVAR) frame work and it was passed through a series of diagnostic and stability. Finally the Generalised Impulse Response Function (GIRF) was employed to examine the dynamic relations among the variables under study. The results show that there is a positive relationship between economic growth and oil prices fluctuations.

Keywords: Oil prices, Economic Growth, CVAR, Generalised Impulse Response Function, Johansen's method, South Africa,

JEL Classification:

GLOSSARY OF TERMS

Brent Crude - a major trading classification of sweet light crude oil that serves as a major benchmark price for purchases of oil worldwide. Brent Crude is extracted from the North Sea and comprises Brent Blend, Forties Blend, Oseberg and Ekofisk crudes (also known as the BFOE Quotation).

Economic growth - an increase in the total output of a nation over time. Economic growth is usually measured as the annual rate of increase in a nation's real GDP.

Exchange rates - The rate, or price, at which one country's currency is exchanged for the currency of another country.

Gross domestic product (GDP) - The value, expressed in dollars, of all final goods and services produced in a year.

Gross domestic product (GDP), real - GDP corrected for inflation.

Imports - Goods or services bought from sellers in another nation.

Inflation - A sustained and continuous increase in the general price level.

Law of demand - The principle that price and quantity demanded are inversely related.

Law of supply - The principle that price and quantity supplied are directly related.

Monetary policy - the objectives of the central bank in exercising its control over money, interest rates, and credit conditions. The instruments of monetary policy are primarily open-market operations, reserve requirements, and the discount rate.

Price - The money value of a unit of a good, service, or resource

LIST OF ACRONYMS

ADF	Augmented Dickey Fuller
CLRM	Classical Linear Regression Model
CPI	Consumer Price Index
CVAR	Cointegrated Vector Auto Regression
ECT	Error Correction Term
GDP	Gross Domestic Product
GIRF	Generalized Impulse Response Function
IMF	International Monetary Fund
KPSS	Kwiatkowski, Phillips, Schmidt and Shin
MSA	Main Supply Agreement
OLS	Ordinary Least Squares
OPEC	Organisation of Petroleum Exporting Countries
SARB	South African Reserve Bank
SASOL	South African Synthetic Oil Liquid
SDA	Secondary Data Analysis
USA	United States of America
VDC	Variance Decomposition
VECM	Vector Error Correction Model

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CHAPTER 1

INTRODUCTION

1.1 Introduction and Background

A cause for distress for most of the world economies including South Africa is oil price fluctuations. Since the basis that oil consumption is considered as one of the key determinants of the economic activities for any country, consequently economic growth in many countries is hampered by price fluctuations. According to Pretorius and Naidoo (2011) uphold that the oil market is the most unstable of all the markets in the economy. While controlling only 10% of the world's oil reserves, North America, Europe and Asia-Pacific consume approximately 80% of the world's oil reserves. Simultaneously, South America, Africa, Middle East and Russia while controlling 90%, consume 20% of the remaining oil reserves (Beyond Petroleum, 2008).

The demand for liquid fuels in South Africa of 64% is attained through the import of crude oil. The Middle East is the main exporter with approximately 85%, while the remaining comes mostly from the African region with 15%. The Middle East and some parts of Africa are the two regions that supply South Africa with crude oil although they are highly predisposed to geopolitical instability. South Africa is extremely vulnerable to both national security and economic problems due to extreme dependence on imported oil from high-risk regions. A different strategy is required in reducing this vulnerability to energy security (Wabiri and Amusa, 2011).

Over the years the crude oil market in South Africa has transformed. Pending 1954 all oil products which could not be recycled were imported in South Africa. The country succeeded in developing the synthetic oil and fuel processing facilities since 1954, of which within the African continent only Egypt was able to exceed. The dissolution of the basic service agreement Main Supply Agreement (MSA) in 2003 also brought about an important change in the country's liquid fuels market (Swart, 2009).

Since 2006, oil prices have been volatile despite all the advances made (Umar, 2010). With moderate downward trend, the South African Reserve Bank (SARB) upholds that the international crude oil prices have been high though fairly stable in recent years since 2011. For most part of the three years Brent crude oil has traded between US$100 and US$120 per barrel and its price at about US$108 per barrel has been in the bottom half of the range in 2014.

Geopolitical instability in major oil producing countries has hampered growth even though the effect was offset by strong US shale oil growth; consequently international markets have not experienced any supply problems. Due to currency movements which pass through to the basic fuel price completely and quickly, domestic oil prices have been on an upsurge and volatile (Umar, 2010). The basic fuel oil price1 in South Africa has basically increased by a cumulative 71 cents in 2014, and by June 2014 unleaded petrol in Gauteng Province cost R14.02 per litre, up from R13.02 in November 2013. The SARB also points out that the currency appreciation has provided some relief, with the price of 95-octane petrol declining by 37 cents per litre over May and June 2014.

According to Nkomo (2006) in the determination of international crude oil price, there have been three periods historically documented. Prices were determined mainly by multinational companies, until the1970s when the Organisation of Petroleum Exporting Countries (OPEC) affirmed its ability to sway oil prices by means of output decisions. Nonetheless by the late 1980s, world oil price were regulated by a market-related pricing system which linked oil prices to the market price of particular reference crude (Farrell, Kahn and Visser, 2001).

The major players such as PetroSA and SASOL participate in petroleum marketing; storage and refining with locally based energy corporations, who then import crude oil into South Africa through private players. The price of crude oil in the international markets is linked to the price of petrol in South Africa. Consequently with any increase in the price of crude oil like over the past three years, the price of petrol has to increase so that crude oil refineries are able to cover their own costs (Wabiri and Amusa, 2011).

[1]This reflects the price of refined oil, excluding levies and surcharges imposed by the government.

1.2 Problem Statement

The South African economy is not an oil producing economy but rather relies heavily on importing from oil producing nations. The implication is that the ever increasing oil prices are the key distress to all developing countries including South Africa. They have a huge impact on the regular consumption pattern of households. Samwel, et al. 2012 argue that oil prices, especially to petroleum oil importing countries, have acted as a major economic burden since the pricing of this crucial commodity is determined entirely by the oil exporting countries.

The consequence is that rising oil prices and price volatility suppress economic activity and diminish asset values. Yang, Hwang and Huang (2002) argue that higher oil prices yield successive recessions in oil-consuming nations, as oil prices are negatively correlated to economic activities. For energy-importing countries like South Africa, oil turns to be the key to the country's energy security. That being the case, the challenge is that high oil prices are a main threat to the economy's overall energy security and lead to high direct costs to consumers.

According to Samwel, Isaac and Joel (2012) the level of petroleum consumed in a country depends on several factors which among them include its prices, the level of economic activity, rate of inflation and the exchange rate, among others. Generally, most of these factors have been constantly fluctuating in developing economies like South Africa. The specific objective of this study is to analyse the impact of oil prices on economic growth in South Africa. Other key macroeconomic variables such as exchange rate and consumer price index (CPI) will be added as independent variables to the model. The study draws implications for macroeconomic policy and it estimates a VAR model to determine the macroeconomic relationship between oil prices and the economic performance in South Africa.

1.3 Aims and Objectives

- The main aim of this study is to empirically examine the impact of oil price fluctuations on economic growth,
- To investigate the direction of causality between oil prices and economic growth in South Africa by VECM approach.

1.4 Research Question

What is the impact of the fluctuations of the oil prices on the economic performance of the South African economy?

1.5 Significance of the study

The significance of this study is that the relationship between oil price and economic growth has received an overabundance of theoretical and empirical research over the past years but have however concentrated largely on the USA and other developed economies of the world. With less attention to the emerging ones, this study attempts to take advantage of this research gap in order to extend the existing literature in the South African context. Determining such a relationship will not only be helpful to the academic community but also to the policy makers and the international community. In shaping a portfolio of measures to reduce South Africa's oil-import vulnerability, policy-makers should consider the risks associated with imports from each of the supply sources. High risk-weight implies high costs and potential insecurity of supply, a situation that can imply higher prices on oil-related products. Decision-makers should also consider the effects of different oil-import strategies and the need to foster bilateral relations with less risky oil suppliers (Stringer, 2008).

1.6 Organisation of the study

The study is divided into five chapters.

In this chapter, an orientation for the rest of the study was provided. The problem statement and research objective, as well as the research design and methodology were explained. In the next chapter, the literature review will be explored. Following this introductory chapter, Chapter 2 explores theoretical literature and empirical evidence surrounding the impact of oil prices on economic growth. Chapter 3 focuses on the methodology to be employed in the study, empirical model specification, the theoretical background of the model. The empirical analysis of the adopted tests on South African data will be presented in Chapter 4. Chapter 5 gives a presentation of results on the effects of oil policies in South Africa.

1.7 Conclusion

Over the years numerous theories have been established on the theories of oil prices and economic growth. These theoretical advances originate from proposals by an array of competing schools of thought in economics: the Keynesians, the Monetarists and the Classical theorists. These models range from the traditional VEC model, the VAR models and Multi-country economic models. Many studies have with time employed these models and applied them empirically. Some results are however inconclusive as to whether a relationship exists between economic growth and oil prices. While others propagate the significance of this relationship. In other studies, the relationship between economic growth and oil prices has been negative (for example Hooker, 1996). But in the case of South Africa several scholars have found the existence of a significant relationship between economic growth and oil prices.

CHAPTER 2

THEORETICAL AND EMPIRICAL LITERATURE REVIEW

2.1 Introduction

The literature review section of this study focuses on the theoretical and empirical literature which is relevant to this topic. The purpose of this section is to identify through literature the set of variables that may potentially build a model of this study.

2.2 Theoretical Perspective

The correlation between oil price and economic growth has received an excess of theoretical and empirical studies during the past years; however, much literature has remained focused largely on the USA and other industrialized economies of the world. Several theories such as the supply side channel, the demand side channel, asymmetric response, Hubbert's Peak theory, Keynesian theory, Neo Classical theory and the Endogenous growth theory are discussed in this section.

This section of the study presents a number of empirical and theoretical studies on the effects of oil price activities on economic growth. The study reveals on literature based on oil prices which explains the relationship between economic growths in South Africa. At the outset this study deals with the theoretical literature, whereby the second part analyses numerous empirical studies on the effect of oil prices in both developed and developing economies and particularly in South Africa

2.2.1 Supply Side Channel

Oil is described as a contribution to the production process from the viewpoint of supply side shock effect. Production costs automatically increase as a result of increased oil prices. As a result, the rate of unemployment rises due to a lower productivity which then decreases total output.

For oil importing economy the transmission process scenario is typical whereas for an oil exporting economy there is increased revenue due oil price shocks which contribute investment opportunities being increased, which then reduce the rate of unemployment and enhances output. Oil is measured as a production output as a result the supply side is expounded from the viewpoint of rising production costs. The production volume is undesirably affected as a result. Furthermore, impacts on investments decisions rely on the expectations of people on the future of changes in oil prices (Schneider, 2004).

According to Gatuhi and Macharia (2013), changes in oil prices impact on economic activity through both demand and supply side channels. The fact that oil is an important production input could be explained through supply side effects. Consequently, the demand for oil is reduced when oil prices increase, which in turn lowers productivity of input factors that prompt firms to lower output. Moreover, changes in price of oil have demand side effects through investment and consumption.

2.2.2 Demand Side Channel

Hunt et al. (2001) note that oil price upsurges transform to increased production costs, most importantly to commodity price increases at which corporations retail their goods in the market. Higher commodity prices then transform to lesser demand for goods and services, consequently dwindling aggregate output and employment level.

Hunt et al. (2001) also suggests that a rise in oil prices affect aggregate demand and consumption in the economy. The transfer of income and resources from an oil-importing to oil-exporting economy is expected to reduce worldwide demand as demand in the former is likely to decline more than it will rise in the latter. The subsequent lower acquiring power of the oil-importing economy translates to a lower demand. Moreover, oil price volatilities pose economic ambiguity on imminent performance of the macro-economy. Societies may perhaps suspend consumption and investment decisions until they see an improvement in the economic situation.

Generally, an upswing in oil prices causes a leftward shift in both the demand and supply curve, resulting to higher prices and lower output (Hunt et al., 2001).

2.2.3 Asymmetric Response

Davids and Holtwinger (2001) argues that asymmetric responses between oil prices and other explanatory variables such economic growth responses should be acknowledged. One of these consists of sectoral shifts hypothesis. Volatility in oil prices can lead to several costs as employees can lose employment in one sector and will only be slowly rehired in others as costs are marked by net changes in aggregate employment.

Secondly, is the demand decomposition mechanism which operates eventually through employment but begins as a disturbance to sector-specific demand. Demand for durable goods is predominantly hit during recessions because consumers have a habit of smoothing the reduction in consumption of non-durables. Lastly, is the investment pause effect in which drops in orders and purchases remain uncertain.

Several researchers debated that the uncertain economic effects of oil prices spikes may considerably be resilient than the favourable economic effects of oil price drops. Every bit of oil price fluctuations can induce sectoral reallocations and create doubts about the returns to irreversible investments. Oil price decreases, unlike increases, have positive real income effects that counterbalance these negative impacts. Various time series modellers include nonlinear, asymmetric oil price specifications to deal with this phenomenon (Hamilton, 2000).

Hamilton (2000) found a 10% rise in oil prices from 1949:2 to 1980:4 that resulted from four quarters in a level of GDP growth that is 1.4% lesser that it actually would be.

Hamilton's study also found that more data was added by more studies until 1988 which also included the oil price collapse in 1986. Mork (1989) investigated the real price of oil. Since 1974, Mork also ran with the refiner acquisition cost (RAC) for imported and domestic crude oil. As an alternative to using the producer price index for crude oil, which simply reflected controlled prices of domestically produced oil[1].

Hamilton's results were verified by the study which postulates that there is a negative correlation between oil price increases and output growth. An assumed linear relationship between economic growth and oil price changes would suggest a stimulation of economic growth by an oil price decrease. In the 1980s however, changes in oil prices decelerated economic growth although oil price declines also followed. Hence, Mork investigated possible asymmetric effects of oil market disruptions.

2.2.4 Hubbert's Peak

A US geologist, Marion King Hubbert founded the 'peak oil theory' in 1956, which postulated that US production would reach its maximum by the early 1970s, when almost half of total resources will have produced, given the bell shaped curve of the production profile of individual oil regions in the states. The simple rationale behind this was simple. The basic assumption is that the production profile of any oil producing region follows a bell shaped curve, the maximum of production necessarily parallels to the point when about half of the total recoverable resource has been produced. The original theory was indeed verified as US production peaked in 1972 and the development of the Alaskan oil fields allowed some rebound up until 1985, a recent study by the government of Australia on the future of oil production confirms the validity of Hubbert's curve, at least for the US lower 48 regions, from the start of production until 2010.

2.2.5 Keynesian Theory

The typical Keynesian model comprises of the Aggregate Supply (AS) and the Aggregate Demand (AD) curves as illustrated in figure 2.1, which accurately demonstrates the oil and economic growth relationship. This model illustrates that in the short run, the (AS) curve is upward sloping rather than vertical, which is its critical feature. If the (AS) curve is vertical, changes on the demand side of the economy affect only prices. Conversely, if it is upward sloping, changes in AD affects both price and output (Dornbusch, Fisher and Kearney, 1996).

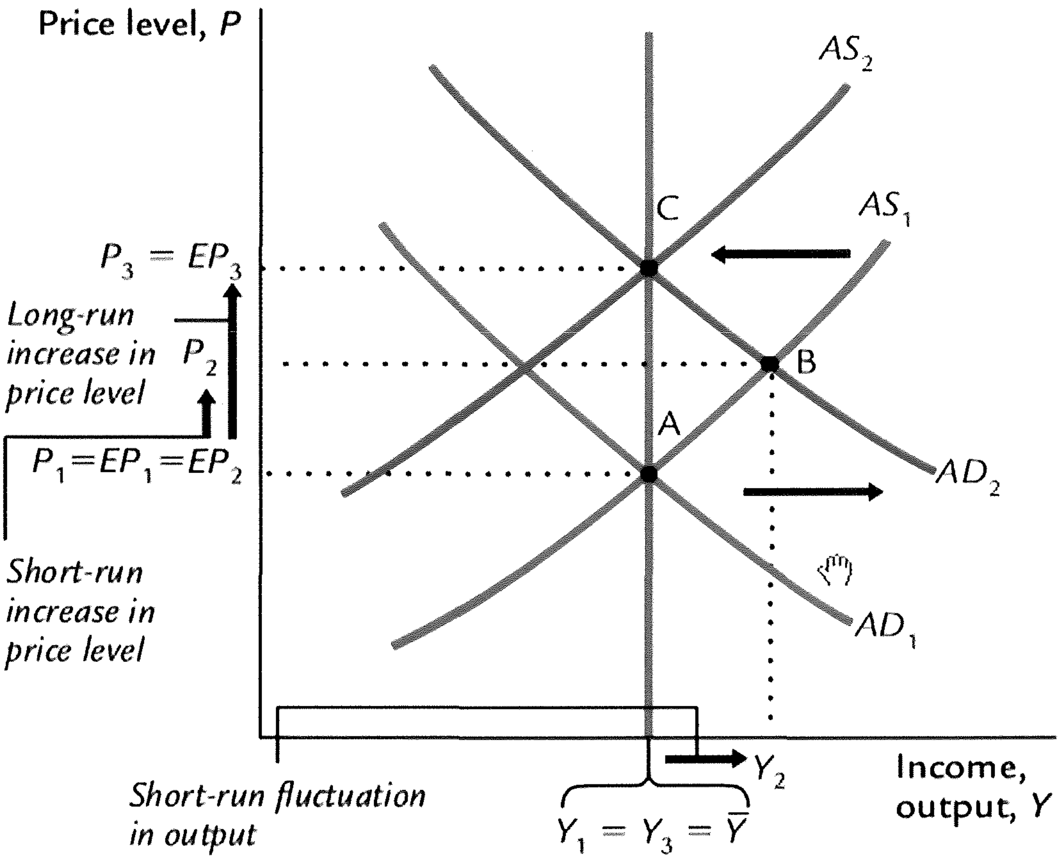


Figure 2.1 Keynesian Theory

Source: Pindyck and Rubinfeld (2009)

2.2.6 Neo-classical Theory

The Neo-classical theory originally was proposed by Solow (1956) and Swan (1956). The theory demonstrated diminishing returns to labour and capital independently and constant returns to both facets jointly as demonstrated in figure 2.2. Technological change substituted investment (growth of K) as the crucial factor explaining long term growth and its level was assumed by Solow and other growth academics to be determined independently, that is autonomously of all the other factors (Todaro, 2000).

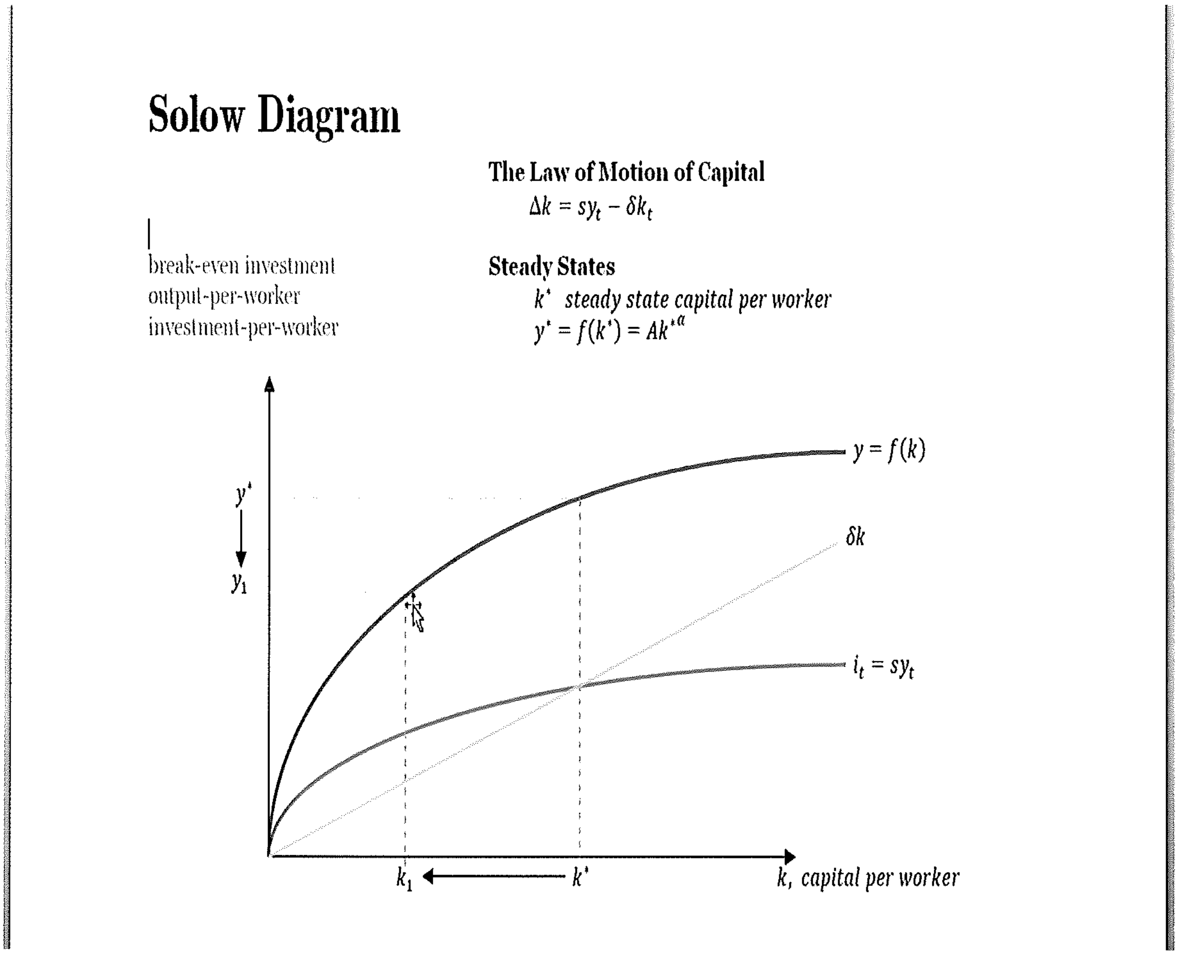


Figure 2.2 Neo Classical Theory

Chamberlain and Yueh (2006)

2.2.7 Endogenous Growth Theory

Endogenous growth theories denote economic growth which is caused by factors within the production process. In endogenous growth theories, the growth rate has an explanatory on one variable which is the rate of return on capital. Representations or models of endogenous growth also consent increasing returns to scale in total productions and also focus on the role of externalities in determining the rate of return on capital. Endogenous growth models that expound growth beyond human capital develop growth theory by suggesting that the growth rate also depends on the rate of return to human capital, as well as physical capital (Lucas, 1980).

2.3 Empirical literature review

Hamilton (2003) projected an elastic nonlinear form and found evidence for a threshold effect, in which an oil price increase that simply reverses a previous decrease seems to have little effect on the economy. Hamilton (1996), Davis and Haltiwanger (2001) and Balke, Brown and Yücel (2002) produced evidence in support of related specifications, while Carlton (2010) and Ravazzolo and Rothman (2010) described that the Hamilton (2003) description performed well in an out-of-sample forecasting exercise using data as it would have been available in real time.

Kilian and Vigfusson (2011) found weaker proof of nonlinearity than stated by other scholars and Hamilton (2011) recognised their weaker proof to the use of a shorter data set and deviations in specification from other scholars. An adverse effect of oil prices on the real output has also been reported for a number of other nations, particularly when nonlinear functional forms have been employed. Mork and Olsen (1994) found that oil price increases were followed by decreases in real GDP growth in 6 of the 7 the Organisation for Economic Co-operation and Development (OECD) countries studied, the one exception being the oil exporter Norway.

Cuñado and Pérez de Gracia (2003) found a negative correlation between oil price changes and industrial production growth rates in 13 out of 14 European economies, with a nonlinear function of oil prices making a statistically significant contribution to forecast growth rates for 11 of these. Jiménez Rodríguez and Sánchez (2005) found a statistical significant negative nonlinear relation between oil prices and real GDP growth in the U.S., Canada, Euro area overall, and 5 out of 6 European countries, nevertheless not in Norway or Japan. Kim (2012) found a nonlinear relation in a panel of 6 countries, while Engemann, Kliesen, and Owyang (2011) found that oil prices helped forecast economic recessions in most of the countries they investigated.

The empirical literature is focused to corroborate the pragmatic relationship between business cycles and oil price fluxes that developed after 1973, the inception of the first oil price shock. Darby (1982) and Hamilton (1983) were the first two academics who predicted the impact of oil price increase on real income in the U.S. and other industrialized economies. While Darby (1982) was dissatisfied with the ability of the variables included to explain the recession which hit the U.S., Hamilton (1983) established that a statistically significant relationship between oil price changes and real GNP growth for the U.S. economy from 1948-1972 and 1973-1980. The negative correlation between oil price volatilities and economic growth revealed a pivotal link from oil prices to aggregate economic activity.

2.3.1 Oil and efficient market theories

In theory, a market is presumed to be adequately resourceful if there is no transaction cost. Also, if all accessible information is unrestricted and obtainable to all market participants at the same time and all market participants agree on the repercussions on the current and future prices of securities (Fama, 1970).

Lee et al (1995) and Hamilton (1996) suggest non-linear transformations of oil prices to reconstruct the negative relationship between the increases in oil prices and economic recessions. Lee et al (1995) debated that the transformations are scaled specifications and net specifications.

Hamilton (1996) postulates that the objective of scaled specification (SOP) is to justify the volatility of oil prices by using GARCH, while the objective of net specification (NOPI) emanates from consumption decisions. Additionally, it is more accountable to measure an oil price increase by linking the current price to a previous time independently. In that way an oil price increase is acknowledged only when the current oil price is larger than its maximum value over the preceding years.

Lee et al (1995) argue that oil price fluctuations are expected to have a larger impact on GDP in an environment where the oil price has been constant than where the oil price fluctuates regularly.

Hamilton (2003) discovers that by utilizing the net oil price increase (NOPI), the significant correlation between oil prices and GDP still existed in the early 1990's and a non-linear function of oil price fluctuations is better to predict GDP.

Oil price increases have an opposing effect on investment by increasing the company's expenditures. Furthermore, to these demand and supply effects oil price fluctuations could impact the economy through foreign exchange markets and inflation (Park, 2007).

Economic theory states that oil price fluctuations affect economic movement both through demand and supply channels. Supply side properties could be described centred on the fact that oil is a vital input in production. As a result, oil price increases reduce the demand for oil, decreasing productivity of other input factors which induce firms to lower output (Gatuhi and Macharia, 2013).

Furthermore, oil price fluctuations have demand side properties through consumption and investment as consumption is affected ultimately by its positive relation with income disposal. When oil prices escalate, an income transfer arises from oil importing nations to oil exporting nations. Thus, consumption in oil importing nations decrease and the degree of this effect is greater as the more the shocks are apparent to be long lasting (Gatuhi and Macharia, 2013).

Miguel, Manzano and Martin-Moreno (2003) examined the macroeconomic effects of oil price shocks with a dynamic general equilibrium model of a small open economy for Spain. Oil is incorporated as an imported productive input in the model, oil prices and interest rates are presumed to be set the international market. The model reproduces Spanish GDP closely from 1970 to the 1980's, regarding exogenous oil price shocks, while it reproduces less for the year 1985 to 1998.

Dagut (1978) revealed on various practical and theoretical features of the first oil shock and illustrated that gold delivered only a provisional buffer against the subsequent international economic fallout. According to the 1979/80 oil shock experience, Kantor and Barr (1986) predicted that although the replicated rate of inflation consequently dropped to below its starting rate, a 10% increase in the petrol prices resulted in a 0.7% point increase in consumer inflation after seven months.

While Van der Merwe and Meijer (1990) offer a detailed vivid explanation of the first three oil shocks, focusing on the effects of the shocks on the terms of trade, domestic inflation and the gold price.

Jimenez-Rodriguez and Sanchez (2005) proposed that while the theoretical literature is normally not clear about irregularities in the response of the real activity oil prices, the modern empirical literature has consequently advanced into the area of non-linear modelling. The foremost exemption to this is specified by one economic rationalization for an asymmetric relationship that has been offered in the literature.

Lilien (1982) theorized the dispersion hypothesis. The hypothesis depends on the disagreement that an oil price change amends the equilibrium allocation through various regions. This description narrates to the adjustment costs resulting from the implied sectoral reallocation of resources. This theory argues that a decrease (increase) in the price of oil leads to a (contraction) expansion of energy resourceful sectors comparative to energy intensive sectors.

Kliesen (2008) indicates that the price elasticity of the demand in the short term is low for oil, because consumers and firms cannot change their consumption or production patterns instantaneously, so the effects of higher oil prices on GDP might be minor. Therefore, the negative demand shock for energy intensive goods may the reason for considerable reallocation of labour, which if exorbitant, can have a great influence on the overall economy even if oil as a share of GDP is low.

Rotemberg and Woodford (1996) postulate that monopolistic producers can weaken output by increasing their mark-ups during oil price volatilities. Finn (2000) modelled differences in using rates for productive capital as a purpose of energy use, and discovered that oil price shocks cause severe, concurrent declines in energy use and capital use with large effects on output.
Jimenez-Rodriguez et al. (2005) give three explanations of why the decrease in energy prices in the 1980's was unsuccessful to offshoot economic growth points to unbalanced effects, which arise through no less than two important channels. At the

outset, by splitting amounts of the current capital stock obsolete means that whichever change in the energy prices would involve pricey modifications. In addition, the channel is a negative demand shock when energy prices rise or a positive demand shock when energy price fall. Respectively, both shocks interact as the impact of the positive demand shock from falling energy prices is reduced by the need to adjust the capital stock.

To sum up the last channel thus far, theoretical literature has always deliberated exogenous increases to the oil price determined by reduction in oil supply and has tried to comprehend whether the oil price crisis can be considered accountable for the high inflation and low output of the 1970's (Jimenez-Rodriguez et al., 2005).

Bernanke, Gertler and Watson (1997) maintain that the conduct of monetary policy is critical in explaining the phases of global recessions and increased inflation which transpired after the oil shocks in the 70's.

Brent and West Texas Intermediate (WTI) (2001) are the two significant locus prices that are determined respectively on the London and New York futures exchanges. The supply side of the crude oil market consists of output from OPEC and non-OPEC producing countries, whose production choices pivot on economic, political geological factors (Farrell et al., 2001).

Oil supply is determined by the rates of extraction, progresses in extractive technologies which allow improved recovery of oil, depletion as well as new discoveries in the long run. In the short run changes in the OPEC production quotas and short-term supply disturbances due to natural disasters or technical or political factors can have vital costs for supply and hence oil prices. The influence of such factors depends sequentially on the extent of spare production capacity – most conspicuously the United States (Farrell et al., 2001).

Furthermore to these first principles, assumptions and prospects about future supply and demand conditions – which are sequentially stimulated by political and economic conditions – play an enormous part in the determination of crude oil prices on the spot and futures markets, for the most part when inventories are low. These deliberations and factors amplify the volatility of oil prices (Farrell et al., 2001).

The South African economy being a comparatively minor net oil importing country is a price taker on the international oil market. Yet, the downstream local liquid fuels sector is subject to government regulation.

The state administers Diesel, petrol and imposes various taxes and levies which sets wholesale and retail margins over and above a basic fuel price (Nkomo, 2006). In South Africa the basic fuel price is an import parity pricing formula which is solely dependent on the international spot price of refined oil (SAPIA, 2006a). PetroSA and Sasol's synthetic fuels are for that reason afforded the same status as locally refined oil or imported petroleum (Nkomo, 2006). Backus and Crucini (2000) investigated a three country model with no nominal stringencies that show that oil price fluctuations account for a big portion for volatility of terms of trade. The scholars endogenise the oil price through the presence of a third oil producing country. Subsequently there are no nominal rigidities that this structure is unsuitable for monetary policy analysis.

Leduc and Sill (2004) maintain that the concentration is on a closed economy with an exogenous process for the oil price, but it is the first one with nominal rigidities. The investigation makes use of a DSGE model to demonstrate that monetary policy solely plays a secondary role in the recessionary process, but that monetary experts like the central bank more apprehensive about inflation better deals with the problem. Once more, the concentration is on supply shocks, with the price of oil modelled as an exogenous process.

Blanchard and Gali (2007) as well as Killian (2007) emphasize the significance of recognizing demand versus supply shocks to oil price. The academics provide a breakdown of shocks to the aggregate global demand for industrial commodities, demand shocks that are specific to the oil market and real oil price into supply shocks.

By means of this decomposition, the scholar assert that, while the oil price upsurge in the 70s is mostly owed to precautionary demand increase, in the current increase a pivotal role is engaged in recreation to aggregate demand shocks. This was inconsistent with the existing U.S. condition, where researchers did not observe an increase in CPI.

Blanchard and Gali (2007) tried to observe the difference between the several oil price shocks. They found that their concentration on the oil shocks appeared to have an extremely minor impact on economic activity earlier than in the 70s, relatively than on considering the diverse ways in the movements of output and CPI following an oil price increase.

Blanchard and Gali (2007) began from the hypothesis that the basis of the fluctuation in oil price is always the same. In example, an exogenous rise in oil price and study how a dissimilar situation can disturb the transmission of the same shock. The experts took into account the differences in the monetary policy, in addition to the point of wage rigidity and in the fraction of oil utilized in the production which demonstrates that a variation in each of them could reduce the volatility of both prices and quantities in the response to the same oil shock.

On the other hand, the scholars' focus was always on supply shocks, which proved their model unsuited in trying to comprehend how an oil price hike could be complemented by an increase in output and a decrease in CPI like it happened in the U.S. in 2000 (Blanchard and Gali, 2007).

It was rational and sensible to assume that the structure of the economy was progressing positively over time and furthermore, that shocks of a different nature were hitting the economy at the same time. Hence the current oil price hike was expected to be the consequence of both demand and supply shocks. The authors realized that the kind of fluctuations in the structure of the economy investigated reduced the response of inflation and GDP to the increase in oil price.

If at the identical period also a demand shock enhancing oil price was at work, the researchers indicated in their present paper that inflation decreases and output increases. The two shocks collectively amplified oil prices but offset each other in terms of movements in inflation and output and this expounded the decrease in the volatility of those variables. As a final point, as detected in the U.S. in 2000, the general outcome can be a low in inflation and positive growth in GDP, if the demand shock was adequately strong (Blanchard and Gali, 2007).

Cologni and Manera (2008) observed that quite a number of empirical studies have concentrated on the role of monetary policy in countering to oil price shocks. The authors examined whether monetary authorities stiffen monetary policy to avoid inflationary effects, or support economic growth by lowering interest rates.

2.3.2 Oil prices and economic activity

Hamilton (1983) studied the effect of oil price shocks on the U.S. economy utilizing a seven variable VAR system. The scholar discovers that all but one economic recession are led by a vivid oil price increase after World War II. This factor does not mean that an oil price increase causes recessions, but there subsists a statistical significant correlation between oil price shocks and economic recessions.

Burbidge and Harrison (1984) similarly carried out a seven-variable VAR with the monthly data from 1962 to 1982 for the UK, Japan, Germany, the U.S and Canada. The effect of oil price shocks on industrial production in the UK and the US was substantial despite the fact that in Canada, Japan and Germany it was somewhat insignificant, according to the impulse response analysis. Price level impacts were slightly smaller though significant, whereas in the US and Canadian economies were significant.

According to Gisser and Goodwin (1986), the effect of oil price shocks on the US economy using data from 1961Q1 to 1982Q2 by analysing for a regime shift in 1973. The researchers established that the general relationship between the US macro-economy and crude oil price has stabilized over the sample period. In addition, they determined that oil price shocks shift aggregate supply curve, while monetary policy primarily shifts the aggregate demand curve causing robust price effects but long run neutrality with respect to real GDP, which in turn cause large real effects but weak direct price effects.

Hooker (1996) finds to a certain extent different results that in data up until 1973, Granger causality from oil price shocks to US macroeconomic variable to be present, and yet if the data is extended to the mid-1990s the relationship is not strong. He further examined a few possible explanations about an occurrence such as sample period matters, miss-specification of linear VAR equations for the oil price and macroeconomic variables, though not a single one was sustained by the data.

His investigation determines that the oil price-macro-economy relationship has transformed in a way which can't be properly denoted by simple fluctuations in oil prices.

The panel data econometric techniques which control the unobserved heterogeneity and OLS (Ordinary Least Squares) estimation methods' difference is precisely on this factor. In the instance of employment, oil price increase does not decrease total employment in the long run since oil and labour are net substitutes instead of gross substitutes in production (Keane and Prasad, 1996).

Labour supply increases due to the income effect when the oil price increases. Furthermore, following an oil price hike, employment possibilities for skilled labour rise even more intensely, as skilled labour may be a worthy substitute for energy in the production function for most industries (Keane and Prasad, 1996).

Kliesen (2008) indicated that in the short run, if the price elasticity of demand for oil is small, this was due to the reason that consumers and firms could not adjust their consumption or production patterns instantaneously, and as a result the impacts of increased oil prices on economic growth may originally be insignificant. It is monitored that the adverse demand shock for energy intensive goods may the reason for a considerable reallocation of labour, which if pricey can have a huge effect on the general economy even if oil as a share of economic growth is low. Rotemberg and Woodford (1996) advocate that in depressing output, monopolistic producers could escalate their mark ups in the course of oil price shocks.

Mork (1989) extended Hamilton's study by utilizing a lengthier data sample by considering and including oil price controls that were present in the 1970s. Additionally, the author explored the likelihood of an asymmetric reaction to oil price decreases along with increases. The outcome of the study indicated that GNP growths were not related to the oil price decreases and were not statistically significant as oil price increases.

Abeysinghe (2001) discovered that open economies encounter mutually indirect and direct effects of oil prices on economic growth whose degree is contingent on whether the economy was a net oil exporting or importing country.

The successive global recessions and the oil price shocks of the 1970s and 1980s ignited an upsurge of empirical studies by various academics. Though the first empirical studies were likely to find a negative relationship between oil prices and economic growth, scholars focused on oil price shocks in the 1970s and 1980s (Hulten, 1989).

On the other hand, when oil prices sharply declined in the mid-1980s, the negative relationship was increasingly questioned by numerous academics. As a result, quite a lot of empirical studies recommended that the effects of oil prices on the macro-economy was asymmetric, basing their notion that the increase in oil prices should ensure negative impacts on growth, while declining oil prices only generated minor boosts on economic growth (Hamilton, 1996).

During the late 1990s, there was still a rising consensus that began emerging in the empirical literature that there might be a negative relationship between oil prices and economic growth, even though its extent is expected to be minor (Jones, Paul and Inja, 2004).

According to the Energy Information Administration (EIA) (2005), oil is disputably the ideal commodity in the present industrial economy. Even though the industrial revolution was originally power-driven by coal, from the time when oil was discovered in Pennsylvania in 1869, it has in terms of its share of the world's primary energy supply extended increasing importance, as it accounts for the largest share of the market with 37% in 2001 (EIA, 2005).

Oil as an energy source is used to a slighter degree for cooking and heating as well as for electricity generation. On the other hand, its most significant part is as a liquid fuel for transportation. Oil is such an important commodity globally that road transport, airplanes, ships and trains cannot function without it. As a result, sectors such as (tourism) in most countries are highly reliant on oil. For the most part agri-business comprehensively relies on oil for the production of pesticides, fertilizers and herbicides. Oil is also used by the manufacturing sector both as a feedback for numerous products from paints and plastics to pharmaceuticals and for energy as well. A plethora of literature exists on the empirical and theoretical linkages between oil and economic growth (Stern and Cleveland, 2004).

In many production processes oil is a critical input and for that reason a fundamental element for economic growth. Additionally, the consumption of oil by households is stimulated by economic growth. It is thus a small wonder that the price, supply and demand of crude oil is attracting so much attention (Wakeford, 2006).

Olson (1988) asserts that as a part of economic growth the cost of oil is too minute to have a great impact on the macro-economy. Empirical studies conducted by the European Commission, the bank of Canada and the International Monetary Fund (IMF) advocated a significant detachment that was observed between oil price changes and their predicted effects in important macroeconomic models. All studies hypothesized that oil price shocks have considerable macroeconomic impacts.

Cunado and Gracia (2005) studied the relationship between macroeconomic variables such as economic activity and inflation alongside with oil prices for some Asian countries along with many European countries. To check whether changes in oil prices affect macroeconomic variables, the authors essentially used the Granger causality test. The world oil price was calculated as the ratio between the producer price index for all commodities divided by the producer price index for crude oil, whereas the national oil prices are measured using the exchange rate of each of the countries.

Cunado and de Gracia (2004) established that the effects of oil price shocks on inflation and economic growth are limited in the short run though significant. Results deliver additional significant proof of the effects of shocks, if shocks are transformed in terms of the local currency of the country under study. In the cases of Thailand, Japan, South Korea and Malaysia, asymmetric responses of oil price inflation relationship were found. Especially in the case of South Korea given that economic growth relationship is considered. It was stated that Asian countries respond differently to shocks in oil prices.

(Cunado and de Gracia 2004).Three specifications are used for oil price changes: scaled oil prices (SOPI), net oil price increases (NOPI) and real oil price changes. The results observed from the data were that there is no cointegration between two or among three variables. On the broader-spectrum, this means that no long run relationship exists between oil and macroeconomic variables.

Cunado and Gracia (2003) for a second time investigated the industrial production growth for 7 out of 14 European countries and found that it Granger caused when the world oil price is used. Moreover, if the national oil price changes or positive changes in oil prices in the world oil price was used it caused industrial production growth in more countries. The effect of the calculated SOPI by the world oil price was much lower than that of world oil price changes. This simply implied that no indication was found that changes of oil prices on macroeconomic variables relied on the volatility of the oil market.

The academics established that not only through an inflation channel but also through other mechanism do oil prices Granger cause economic activity. Changes in oil prices have had a negative and significant effect on industrial production in 9 out of 14 countries, regarding the asymmetric impacts of changes in oil price on the countries' growth, while oil prices declines had an insignificant effect (Cunado and de Gracia, 2003)

Cologni and Manera (2007) using a different approach somewhat inspected the relationship among interest rates, inflation and oil price. The scholars conducted a structural cointegrated VAR model for G-7 countries. According to the structural VECM, the estimated coefficients, only in the UK and Canada do structural oil price shocks affect output significantly.

No significant response of output to oil price shocks at the 5% level of significance was found in all the countries, in the impulse response analysis. However, oil price shocks have a significant effect on inflation and exchange rate. In the 1990s, a significant effect in the US was credited to the reaction of the monetary policy while for France, Italy and Canada, the general effect was offset partly by easing monetary policy.

2.3.3 Monetary policy and oil prices

Leduc and Sill (2004) established in their DSGE model that approximately 40% to the drop in real output following a rise in the price of oil is due to monetary policy. While Carlstrom and Fuerst (2006) discovered that the total weakening in the US real output resulting from an oil price shock may be due to oil and none attributable to monetary policy.

Killian and Lewis (2009) of late re-estimated the Bernanke, Gertler, and Watson (BGW) model under the hypothesis of symmetry. The authors indicated that no proof was found that monetary policy responses to oil price shocks were responsible for recessions of the 1970s and the 1980s, disagreeing with the supposition of BGW. Even though a small number of academics have questioned the description in the BGW, the logic for the policy reaction the academics insisted on was not self-evident. One of the problems (Killian and Lewis, 2009) found on the BGW model was evidence that improvements to oil prices were exogenous regarding the US economy. The current literature has recognized that oil price shocks do not take place in a vacuum; this notion violates the principle of the study in the BGW model.

Killian and Lewis (2009) however presented that on average the Federal Reserve has been reacting differently to oil price shocks determined by international demand pressures than to oil shocks driven by oil supply interruptions. These results propose that the DSGE models of monetary policy reactions in particular must account for a number of structural shocks in the crude oil market, every one of which may require a different policy response. To be brief, it will not be logical for a central banker to react to all oil price shocks the same way without regards to the causes of the oil price shock.

Nakov and Pescatori (2009) methodically recognized this point. The researchers demonstrated that it is suboptimal from a welfare approach for a central bank to react to oil price shocks rather than to the primary causes of oil price shocks, all this within the context of a stylized DSGE model.

Romer and Romer (1989) examined whether monetary policy plays a role global recessions by separating six exogenous monetary policy shocks after investigating the record of policy actions of the Board of Governors and Federal Open Market Committee (FOMC). These monetary policy shocks are referred to as Romer dates, which are formed to create recession to lessen inflation. The scholars run a VAR model to inspect impact of monetary policy shocks over the period of 1948 to 1987 and conclude that six out of the eight post-war recessions are caused by the tightening monetary policy shocks. They correspondingly check the role of monetary policy shocks by not including two monetary shocks which are associated with oil price increases, but outcomes are not different.

Dotsey and Reid (1992) re-assessed the impacts of oil price shocks and monetary policy shocks on the economy by means of VARs. The researchers ran a regression to restructure the effects of oil price shocks and find that positive oil price shocks were related with a reduction in industrial production and Romer's contractionary monetary policies, while monetary policy shocks were insignificant. They also used federal funds rates as an alternative of M1 as a monetary policy indicator and showed that positive oil price shocks along with interest rates have a substantial role in explaining GNP variations based on variance decomposition analysis and on impulse response. They resolved that both strict monetary policy and oil price upsurges are statistically associated with economic recessions.

Barsky and Killian (2002) provided proof that in the 1970s, oil price shocks were not caused by stagflation but mainly by monetary contraction and expansion. They presented that in the 1970s dramatic and across-the-board escalations in the price of industrial commodities occurred, to which an economic growth was affected by expansionary monetary policy and not by a specific supply shock.

Barsky and Kilian (2002) suggest that in the absence of major shifts in monetary policy regimes since the 1980s there is no reason to expect stagflation to happen. This simply implies that monetary policy makers seem to have adopted on lessons from the past. In the 1970s, price stability has become universally accepted as one of the key objective of monetary policy.

2.3.4 Asymmetric effect of oil price changes

Mork (1989) explored whether a strong relationship continued to hold between changes in oil prices and the GNP growth rate in the US established by Hamilton when the sample period was protracted to the oil price downfall in 1986 and the oil price was amended for the effect of oil price control. The researcher establishes that a negative correlation between GDP growth rate and increased oil prices still exists. Though the real effects of oil price declines were different from those of oil price increases, with oil price drops they were not having a statistically significant effect on the US economy. An asymmetric impact is apparent.

Balke et al. (2002) provides a similar explanation of the asymmetric effects oil price shocks have on economic growth. The real effects of monetary policy alone cannot explain shocks on real GDP. The scholars also conclude that interest rates appear to be an important mechanism through which oil prices affect economic output.

An understandable benefit of this discussion of empirical models was that they do not oblige the scholar to take a stand on the instrument causing the asymmetry of reaction to oil price shocks. As a final point, these models were reflected to be sounder than conservative models because they produced much larger responses to positive oil price shocks, in line with subjective beliefs about the importance of oil price shocks for the economy (Bernanke, Gertler and Watson, 1997).

Current research, though, has revealed that the response approximates reported in this literature are false for the reason that this kind of asymmetric models of the transmission of energy price shocks is essentially miss-specified (Killian and Vigfusson, 2009).

Killian and Vigfusson (2009) constructed models produce unpredictable parameter estimates. Additionally, the responses of output and employment to energy price shocks in these models were regularly calculated inaccurately, causing the projected responses to positive oil price shocks to look greater than they originally are. In conclusion, the statistical tests used in provision of allowing for asymmetric responses to oil price shocks were inappropriate for the task. Further applicable tests proposed showed no statistical significant evidence of asymmetric responses to energy price shocks for the US.

Edelstein and Killian (2009) described that petrol prices permanently and unexpectedly increased by 25 cents per gallon (other things remaining equal and oil prices remain unchanged, this would suggest that a 6.85% increase in the total price of oil). Ceteris paribus, Edelstein and Killian's (2009) estimates imply that real GDP would decrease on average by 0.63% one year after the oil price shock. Originally, scholars conducted experiments with models in which only oil price increases matter. Though current research has refined this idea and introduced measures of net oil price increases.

Table 2.1 Macroeconomic Impacts of Oil price Shocks: Selected Results

Study	Data	Methodology and Variables	Is Energy Significant
Mory (1993)	USA; Annual 1952-1990	OLS (Y, OP, MP, GOV)	Yes
Lee et al., (1995)	USA; Quarterly 1949-1992	VAR (Y, OPV, MP, IP, UN, W, INF)	Yes
Ferderer (1996)	USA; Monthly 1970-1990	VAR (Y, OPV, OPV MP)	Yes
Hooker (1996)	USA; Quarterly 1947-1974	VAR (Y, OP, MP, IP, INF)	Yes
	USA; Quarterly 1974-1994		Yes
Hamilton (1996)	USA; Quarterly 1948-1994	OLS (Y, OPV, MP, INF, IP)	Yes
Darrat et al., (1996)	USA; Quarterly 1960-1993	VAR (Y, OP, MP, FP, W, R)	No
Lee et al., (2001)	Japan; Monthly 1960-1996	VAR (Y, OPV, MP, INF, R, CP, GOV)	Yes
Cuñado and Pérez de Gracia (2003)	15 European Countries; Quarterly 1960-1999	VAR (Y, OP, INF)	Yes
Jiménez-Rodriguez and Sanchez (2005)	9 OECD Countries; Quarterly 1972-2001	VAR (Y, OPV, INF, R, W, EX)	Yes
Maruping (2014)	RSA, Quarterly 1990-2013	CVAR (Y,OP, INF, EX)	Yes

Notes: VAR is Vector Regression, Y is economic growth, OP is oil price, INF is inflation and EX is exchange rate. Note that the ordering of variables within the brackets does not reflect the order of the VAR within the corresponding study.

The literature on economic growth and oil prices advocates that oil price shocks led to a recession. The empirical findings of various studies depicted in table 2.1 suggest that oil prices upsurges negatively affect oil importing economies. Despite the fact that the structure of several economies may affect the magnitude to which economic growth is slow following a price shock, the findings also imply that oil price shocks contribute to volatility in most countries. The table 2.1 above presents the energy economic growth models, data, methodology and compare the findings of South Africa to that of other countries studies.

2.4 Conclusion

In conclusion, oil prices have an important effect on the economic growth of most countries and the effects in oil exporting countries are somewhat different from those in oil importing countries. Upcoming academic papers on oil should scrutinize the trade cataloguing of countries commonly affected by oil price shocks. The global economy reacts to increased oil prices by increasing interest rates, on the other hand real interest rates become negative, as a result the increase in inflation exceed the rise in interest rates. Therefore, monetary policy remains simulative. To sum up, bearing in mind that there is a possibility the monetary authorities might not fully comprehend the transmission of energy prices and subsequently set monetary policy inaccurately. It becomes distinct that movements in oil prices only have minute effects on the general economy, and thus the impacts thereof are likely to be too insignificant to lead to policy miscalculations with substantial economic repercussions.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Chapter two reviewed the literature on various theories and empirical studies on the effects of oil price movements on economic growth and inflation in South Africa. This, coupled with the background on the conduct of oil price shocks, shed some light on the relationship between, oil price, inflation and economic growth in South Africa. This chapter builds on that background to set the analytical framework used in this study.

3.2 Data

Secondary data was utilised in this study to examine attainable data starting from the year 1990Q1-2014Q. A number of sources of data (websites) like SARB, Qantec, and the International Monetary Funds (IMF), among others were considered to find the most appropriate data for this study. The readily available data analysis conducted through secondary data analysis (SDA) makes it more advantageous when coming to time and cost saving. Though it has been the situation, using such methods could be disadvantageous reason being the researcher may not be able to control data collection errors that is reserved in analysis by aims of the original research (Mouton, 2001). In this study quarterly time sequences are favoured for they give a bigger degree of autonomy.

3.3 Econometric model

A VAR model was estimated in this study in order to determine the macroeconomic relationship between oil price consumption and economic performance in South Africa. Econometric tests are performed by applying Econometric Views (EViews 8) software, while the model of this study was projected by using a cointegrating vector autoregressive (CVAR) frame work. According to Hoover, Johansen and Juselius (2008) a simple linear system made available by the CVAR can characterise the possibility of supplying a set of variables. By focusing on well-specified consistent statistical models, from many various uses of cointegration in systems of equations can be identified. By recognising that macroeconomics time sequence, data are usually nonstationary and cointegrated driven, mainly, the development of likelihood-based inference for the CVAR model and, additionally, an applied macro econometric approach. Through the means of Forecast Error Variance Decomposition (VDC), the relative importance of a variable in producing variations in its own value and in the value of other variables can be assessed once the CVAR has been predicted. VDC will facilitate on assessing the relation significance of oil shocks in the unpredictability of other variables in the system.

The anticipated model of this study is articulated in its efficient form as follows:

$$GDP = f(EXCHRATE, INFLRATE, OILPR) \quad 3.1$$

Where:

GDP	the level of economic activity Real GDP in millions
EXCHRATE	is the nominal effective exchange rate adjusted for inflation rate differentials with the US price index as the main trading partner of South Africa. The definition of real exchange rate is such that an increase means a real appreciation of the Rand. An appreciation is meant to hurt the economy's external competitiveness and vice versa for a decrease.
INFLRATE	is defined as the annual changes in CPI of the South African economy
OILPR	is the quarterly nominal average world oil prices deflated by the US consumer price index. A proper definition of oil prices is a difficult task. Here oil prices are used in real terms, taking the ratio of the average world nominal oil price in US dollars to the US Consumer Price Index extracted from SARB database. The definition of oil prices adopted for the study is symmetric oil price growth rates as well as Mork's asymmetric definition of oil price changes.

3.4 Estimating the model

By means of the Augmented Dickey-Fuller (ADF) and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests, the variables were tested for the presence of the unit root. The Johansen cointegration was applied to determine the existence of the long run economic relationship amongst the variables whereas the short equilibrium relations will be determined by the Vector Error Correction Model (VECM) or vector autoregressive model (VAR). However The VECM/VAR helped to determine the fundamental relationship between the variables. The model will pass through a sequence of diagnostic and consistency tests, Variance decomposition and finally the Generalized Impulse Response functions (GIRF) will then be engaged in examining the vigorous associations among the variables under study.

3.4.1 Testing for stationarity (Unit root test)

Specific approaches are required due to the examination of the study which is based on time sequence data. It is commonly known that the econometric appraisal of a model established on time sequence data demand that the series be stationary as nonstationary series usually result in ambiguous inferences. Engle and Granger (1987) make available a regular technique to deal with this problem. This consists of testing the variables of an equation for stationarity.

The estimation, therefore, begins by conducting stationarity test to ascertain the stationarity or otherwise of the variables and the appropriateness of the specification for CVAR estimation. Thus, both the Augmented Dickey and Fuller (1979) and the KPSS (1988) tests are engaged in this study.

3.4.1.1 Augmented Dickey-Fuller (ADF) Test

Dickey and Fuller (1979) contemplate three unlike regression equations that can be used to test the presence of a unit root. Basically the three regressions differ due to the presence of the deterministic elements a1 and a2t given below:

$$\Delta Y_t = \alpha Y_{t-1} + \mu_t \qquad 3.2$$

$$\Delta Y_t = a_1 + \alpha Y_{t-1} + \mu_t \qquad 3.3$$

$$\Delta Y_t = a_1 + a_2 t + \alpha Y_{t-1} + \mu_t \qquad 3.4$$

where Yt is the required time series, Δ is the difference operator, t is the time trend and μt is the pure white noise error term which should satisfy the following assumptions: normality, constant variance and independent error terms. Equation (3.2) is a pure random walk, equation (3.3) adds an intercept or drift term and equation (3.4) includes both a drift and linear time trend. The test involves estimating the equations using the OLS in order to obtain the estimated value of α, and the associated standard error and compare the resulting t-statistic with appropriate value reported in the Dickey-Fuller (DF) tables. The weakness of the DF test is that it does not take account of possible autocorrelation in the error process or term (μt). To cater for the above mentioned problem associated with DF test, the Augmented Dickey-Fuller (ADF) can be used. The ADF include extra lagged terms of the right-hand side of the DF equation (4) in order to eliminate autocorrelation.

The assumptions that the error terms are independent and have a constant variance raises problems related to the fact that (1) the true data generating process may contain both autoregressive and moving average (MA) components. In this case, we do not know how to conduct the test if the order of the MA terms is unknown, (2) we cannot properly estimate α and its standard error unless all the autoregressive terms are included in the estimating equation, (3.3) the DF test considers only a single unit root and (4) it is difficult to ascertain where the intercept and/or time trend belongs (Enders, 1995). In addition, the DF test tends to accept the null hypothesis of unit root more often than is wanted. That is, according to Brooks (2002: 381) and Gujarati (2003:819), it exhibits low power.

3.4.1.2 Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test

The alternative test introduced in 1992 by Kwiatkowski, Phillips, Schmidt and Shin, and called henceforth the KPSS test has a null of stationarity of a series around either mean or a linear trend; and the alternative assumes that a series is non-stationary due to presence of a unit root. In this respect it is innovative in comparison with earlier Dickey-Fuller test, or Perron type tests, in which null hypothesis assumes presence of a unit root.

In the KPSS model, series of observations is represented as a sum of three components: deterministic trend, a random walk, and a stationary error term. The model has the following form:

$$Yt = \xi t + rt + \varepsilon t \qquad 3.5$$

$$r_t = r_{t-1} + u_t \qquad 3.6$$

3.4.2 Cointegration tests

Due to the origin of the theory incorporated variables of the first order, testing for the relationship of such existence is significant because I(1), may consist of cointegration relationship. If variables are collected and are incorporated individually in the same order and there is a slightest single accurate grouping of these motionless, then in can be conclude that they are cointegrated variables. Therefore this kind of variables will be involved in the ling existing connection Johansen (1988). The existence of such a long course connection between economic variables may entail testing for cointegration,

This study contemplates a number of cointegration tests, specifically, the Augmented Dickey Fuller Test (ADF), Kwiatkowski, Phillips, Schmidt and Shin (KPSS) methods and the Johansen's procedure as a replacement for depending on OLS valuation, Johansen's system builds cointegrated variables straight on extreme chance approximation. Thus recognising that this procedure depend on severely on the link between the rank of a condition and its specific roots. For thus reason Johansen used a chronological test to defining the sum of cointegrating vectors by developing the extreme possibility valuation. In the sense that he constructed straight on extreme possibility as an alternative of depending on minimum squares consequently his technique can be seen as auxiliary group approach. Nonetheless his practise is nothing compared to the Dickey-Fuller's multivariate generalisation test.

The trace test:

$$\lambda trace(r) = -T \sum_{1=r+1}^{n} In(1 - \lambda r + 1) \qquad 3.7$$

and

The maximum eigenvalue test:

$$\lambda \max = (r, r+1) = -TIn(1 - \lambda r + 1) \qquad 3.8$$

This procedure is a vector cointegration test method. It has the advantage over the Engle-Granger and the Phillips-Ouliaris methods in that it can estimate more than one cointegration relationship, if the data set contains two or more time series.

3.4.3 Cointegration and vector error correction modelling

Mukherjee at al. (1998) outline that, deterioration of one motion variable on another is expected to produce imposing superficially results which are solely false. Broadly, if two time series variables are both nonstationary in levels but stationary in first variances, they are a merger of order 1, I (1), then a stationary direct relationship between them could be in existence, I (1) and all such series of interest will preferably be integrated in the same manner I (1). These two variables that are regarded to satisfying these obligations are considered to be cointegrated. They are cointegrated with one another if the residuals from the levels regression are stationary.

These should have an error correction representation in order for an error correction term (ECT) to be linked to the model. For the reintroduction of the information lost in the differencing practice a vector error is correction model is produced (VECM), thus allowing for extensive existence equilibrium together with diminutive existence dynamics (Ang and McKibbin, 2006).

The approximating of VECM is included in the following phase, containing figures of both the long run and short run association among variables. It would require one to give in detail for what reasons has the study selected VECM instead of VAR model at this stage. If a variable is found to be possible weakly exogenous it could be descended to an endogenous part of the system. By the number of cointegrating vectors, hypothesised trend and standardising model on the true cointegrating relation(s) a VECM can be predicted. Due to the fact that it gives temporary license connection to develop from initially the sum of the lagged differences of the explanatory differenced variable and also, the coefficient of the error-correction term predominately, Johansen procedure is regarded as good when compared with the standard VAR (Monoj and Manasvi, 2007).

3.4.4 Diagnostic and stability tests descended

Takaendesa (2004) states that in order to test the stochastic properties of the model, such as residual autocorrelation, heteroscedasticity and normality, among others analytical checks will serve a purpose in this regard. For determining that any of these expectations had not been dishonoured they should be conducted on the error-correction mechanism as well these tests.

3.4.1.1 Autocorrelation LM test

The Lagrange multiplier (LM) test developed by Breusch (1978) and Godfrey (1978), has come to be the customary tool in applied econometrics. This test procedure in its pervasiveness derives from its flexibility, simplicity and wide applicability. Autocorrelation denotes to the correlation of a time series with its own past and future values. It is also called "serial or lagged correlation" which talks about the correlation between members of a series of numbers arranged in a time. Positive autocorrelation might be deliberated as a specific form of persistence, a tendency for a system to remain in the same state from one observation to the next (Verbeek, 2000). It also complicates the application of statistical tests by reducing the number of independent observations and also obscures the identification of significant correlation between time series. Autocorrelation can also be exploited for predictions, because future values depend on past and current values. There are three tools which can be used in assessing the autocorrelation of a time series, namely: the time series plot, the autocorrelation function and the lagged scatter plot.

3.4.1.2 Breusch Godfrey Pagan heteroscedasticity test

Heteroscedasticity arises if different error terms do not have identical variances, so that the diagonal elements of the covariance matrix are not identical. The error terms are mutually uncorrelated while the variance of μt may vary over the observations.

The consequence of using the usual testing procedures despite the heteroscedasticity is that the conclusions we draw or the inferences we make may be very misleading (Gujarati, 2003). In this study we employ the Breusch Godfrey Pagan test. The general Breusch Godfrey Pagan test of heteroscedasticity does not rely on the normality assumption and is easy to implement (Gujarati, 2003).

Mukherjee at al. (1998) argue that the basis of this test is to check whether there is any systematic relation between the squared residuals and the explanatory variables. It tests the null hypothesis that there is no heteroscedasticity in which the test statistic should not be significant in the absence of heteroscedasticity and misspecification.

Heteroscedasticity results from a sequence of random variables having different variances. This implies that during regression analysis there is non-consistent variance. Heteroscedasticity is tested using the Langrange Multiplier, also known as Engle's Arch LM test (Engle, 1982).

3.4.1.3 Residual normality test

The assumptions of the Classical Linear Regression Model (CLRM) require that the residuals are normally distributed with zero mean and a constant variance since the violation of this restriction will result in t-and F-statistics being not valid. One way of detecting misspecification problems is through observing the regression residuals. Usually the normality test checks for skewness (third moment) and excess kurtosis (fourth moment) (Verbeek, 2000). Jarque-Bera normality test compares the third and fourth moments of the residuals to those from the normal distribution under the null hypothesis that residuals are normally distributed and a significant Jarque-Bera statistic, therefore, points to non-normality in the residuals (Jacque and Bera, 1980).

We use the Jacque-Bera test to determine whether the ECM is normally distributed. This test measures the difference in kurtosis and skewness of a variable compared to those of the normal distribution (Jacque and Bera, 1980).

3.4.1.4 Serial correlation test

Serial correlation is cross-correlation of a signal (white noise) with itself. It may be caused by nonstationarity of dependent and explanatory variable, data manipulation (averaging, interpolation and extrapolation) or by the incorrect functional form. Ljung and Box (1978) suggested the use of Ljung-Box test to test the assumption that the residuals contain no autocorrelation up to any order k. add more information and explain how you draw a conclusion about the serial correlation test.

3.4.5 Variance decomposition

The essence of the variance decomposition is that it measures the proportion of forecast error variance in one variable explained by innovations in itself and the other variables. But it should be noted that the VAR was estimated with the sets of contemporaneous structural restrictions specified in the equations. One of the characteristics of a VAR system is its ability to conditionally forecast, especially short-term forecasts, future movement of the variables in the system by capturing the individual patterns of movement in the system. In the process, the multi-period forecast error variance decompositions show that how much a random shock to one innovation is responsible for predicting subsequent fluctuation of the other innovation that is not already accounted for by its own prior fluctuation.

3.4.6 Generalised Impulse Response Function (GIRF)

The GIRF analysis describes the effects of a shock to an equation in the model on all of the variables in the system without giving an economic interpretation to the shock. So long as the mapping between the structural shocks and the shocks to the equations of the model remains constant, the analysis of the shocks to the estimated equations provides insights into the response of the macroeconomic model to the underlying structural shocks, taking into account the contemporaneous effects that such shocks might have on the different variables in the model. While this analysis cannot provide an understanding of the response of the macro-economy to specified structural shocks, therefore, it does provide a meaningful characterisation of the dynamic responses of the macro-economy to 'realistic' shocks, meaning shocks of the type that are typically observed in (Perasan and Shin, 1998). This study utilizes the generalized impulse response analysis which was developed by Koop et al. (1996) and Pesaran and Shin (1998). Dissimilar to the conservative impulse response method which normally uses a Cholesky decomposition of the positive definite covariance matrix of the shocks; the benefit of the GIRF analysis is that it doesn't need orthorginalization of shocks. For the reason that the resulting impulse responses are invariant to the ordering of variables in the VAR, for that this method provides exceptional and stout outcomes.

3.5 Conclusion

The procedure involved in Johansen 1988's study and Johansen and Juselius (1990) method is presented in the chapter 4. The cointegration technique has been chosen as the preferred parameter estimation technique for econometric model. This is because of its several advantages over the alternative techniques. Based on the cointegration approach, the error correction model, which contains information on both the long run and short run relationship between variables, is estimated. The estimated model has to pass all the diagnostic checks which involve autocorrelation LM test, white heteroscedasticity test and residual normality test. Having familiarised ourselves with the estimation techniques, we now apply these techniques to South African data in order to achieve the objectives of this study as set out in Chapter one.

CHAPTER 4

EMPIRICAL RESULTS AND DISCUSSIONS

4.1 Introduction

The main aim of this chapter is to examine the relationship between oil prices and the three economic fundamentals (exchange rate, inflation and economic growth) using the CVAR modelling technique. The model regresses the economic growth (GDP) against the real exchange rate, inflation rate and oil prices over the period 1990-2013.

4.2 Unit root tests

The ADF- tests and KPSS-tests are reported in Table 1. The results show that the variables expressed in logs are non-stationary. When all variables are first differenced, there is evidence that all variables are stationary. The estimated statistics of the ADF and KPSS stationarity tests are presented in Table 4.1 and 4.2 for each variable in both level and first difference form. The results suggest that each series in level is I(0), applying the first difference to achieve stationarity. These results indicate that the level form of each series is integrated of order zero. The results of the alternative KPSS test shown in Table 2 do not reject the hypothesis that LOG_GDP, XRATE, LCPI AND LOG_OIL are stationary in levels but the results in first difference form suggest that the null hypothesis cannot be rejected. The results imply the ADF test conclusions that the first difference form of all variables are I(1). Table 4.1 and 4.2 show the results of the KPSS and ADF tests. The results recommend that all variables are nonstationary in levels and stationary in first difference, this means that the variables are I(1).

Table 4.1. and 4.2 Results of the ADF and KPSS Unit Root Tests

Variable	ADF				KPSS			
	Without Trend		With Trend		Without Trend		With Trend	
	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
RGDP	-0.245	-2.816	-3.258	-2.71	1.284	0.285	0.225	0.128#
RXRATE	-0.398*	-8.34***	-7.029	-8.287***	1.276	0.092#	0.183	0.091#
INFL	-0.361*	-9.061***	-3.664	-9.026***	0.636	0.081#	0.152	0.039#
ROILP	-0.351*	-8.884***	-2.691	-8.821***	0.885	0.074#	0.19	0.047#

*Note: *, **, *** represent significance at 10, 5 and 1 % respectively.*

Table 4.3: and 4.4 illustrate the cointegration tests results of both the trace and maximum eigenvalue statistic which indicate the presence of more than one cointegrating equation among the four variables in this model at 0.05 percent level consistent with the critical values. This exposes the presence of a long run equilibrium relationship between economic growth (LOG_GDP) and the variables used in the model. Subsequently, the long run cointegrating relation is present among the variables estimation of cointegration vectors. The value of cointegrating vectors is then derived from the Table 4.5

4.3 Cointegration tests

Table 4.3 Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.433599	58.44911	47.85613	0.0037*
At most 1	0.360665	29.45799	29.79707	0.0547
At most 2	0.095706	6.644303	15.49471	0.6193
At most 3	0.029243	1.513657	3.841466	0.2186

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*

Table 4.4 Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.433599	28.99113	27.58434	0.0328*
At most 1	0.360665	22.81369	21.13162	0.0287*
At most 2	0.095706	5.130646	14.26460	0.7252
At most 3	0.029243	1.513657	3.841466	0.2186

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*

Table 4.5 Cointegrating Vector of South Africa

1 Cointegrating Equations	Log likelihood	86.74104	
Normalized cointegrating coefficients (standard error in parentheses)			
LOG_GDP	XRATE	LCPI	LOG_OIL
1.000000	0.008719	0.194683	-0.194658
S.E	(-0.00478)	(-0.05349)	(-0.12912)

According to tables 4.3, 4.4 and 4.5, a cointegrating equation among LOG_GDP, XRATE, LCPI and LOG_OIL is denoted as follows:

$LOG\_GDP_t = 0.008743 + 0.008719\ XRATE_t + 0.194683\ LCPI_t - 0.194658\ LOG\_OIL_t$ (4)

The signs of the three parameters are as anticipated and greatly significant. The cointegrating vector indicated a stationary long run-relationship in which the level of LOG_GDP depends on the real exchange rate, the inflation rate and real oil prices. Other things being equal, a 1% change or increase in the exchange rate causes the level of economic growth of South Africa to increase by 0.8743%. At the same time, a 1% increase in the inflation rate of South Africa causes the level of economic growth to increase by 19.46% and a decrease of 19.46% in oil prices in the economy. It can be concluded from the above equation that the real GDP of South Africa is more elastic to changes in international oil prices than of real exchange rate and inflation.

4.4 Vector Error Correction Model - Short-run analysis

According to Granger (1969), if evidence of cointegration between two or more variables is present, then a valid error correction model should also exist among the said variables. The error correction model is then a demonstration of the short run dynamic relationship between two variables. This simply suggests that an error correction term will be significant, given that cointegration exists. The estimated bi-variate ECM for South Africa then takes the following form:

$$\Delta LOG\_GDP_{it} = \alpha + \Sigma\beta_{1i}\Delta XRATE_{it-1} + \Sigma\beta_{2i}\,\Delta LCPI_{it-1} + \Sigma\beta_{3i}\,LOG\_OIL_{\,it-1} + {}^{\varphi}\,ECT_{1t-1} + u_{1it}$$

$(i = 1 \ldots n_1)$ $(I = 1 \ldots n_2)$ (3) (5)

where:

Δ is the difference operator,

Log_gdp_t, $xrate_t$, $lcpi_t$ and Log_oil_t are as defined above,

ECT_{it-1} is the error correction term derived from the long run cointegrating relationship,

u_{1it} is the white noise error term

$_t$ denotes the years and

n_1 is the lag orders of α's and β's respectively.

The VECM results distinguish between short run and long run Granger causality. The coefficients of the lagged error correction term show that there is a long run relationship between economic growth and the independent variables. The coefficients of the ECM indicate the speed of adjustment to the long run equilibrium relationship. The following ECM was formed using 96 observations:

$$DLOG\_GDP_{it}{=}0.005{-}0.000DXRATE_{t-4}{+}0.001DLCPI_{t-4+}0.023DLOG\_OIL_{t-4}0.0014ECT_{t-1}$$

Se. (0.001) (0.000) (0.002) (0.009) (0.010) (6)

All coefficients of the model are significant at 1%(*), 5%(**) and 10%(***). The sign of international oil prices are as expected and support the cointegration equation, but the sign for the exchange rate is not as expected.

The error correction term is negative and significant at 5%, so the model is stable and supports the cointegration output results.

A value of -0.0014 of the coefficient of error correction terms advocates that the South Africa economy 0.14% movement back towards equilibrium following a back towards long run equilibrium, after the shock of oil price or the fluctuation of the exchange rate.

Table 4.6 VECM output

Dependent variable: DLOG_GDP

Method: Least Squares

Sample: 1990 – 2013

Observations: 96

Variable	Coefficient	Std. Error	t-statistic
C	0.005179	(0.00197)	[2.62916]
D_XRATE(-1)	-0.000216	(0.00044)	[-0.49702]
D_LCPI(-1)	0.001761	(0.00284)	[0.62050]
DLOG_OIL(-1)	0.023470	(0.00935)	[2.51012]
ECM(-1)	-0.001438	(0.01042)	[-0.13800]

R squared..................= 0.872026

Adjusted R-squared...= 0.842224

S.E of Regression......= 0.010646

Akaike........................= 0.481582

Schwarz.....................= 2.578564

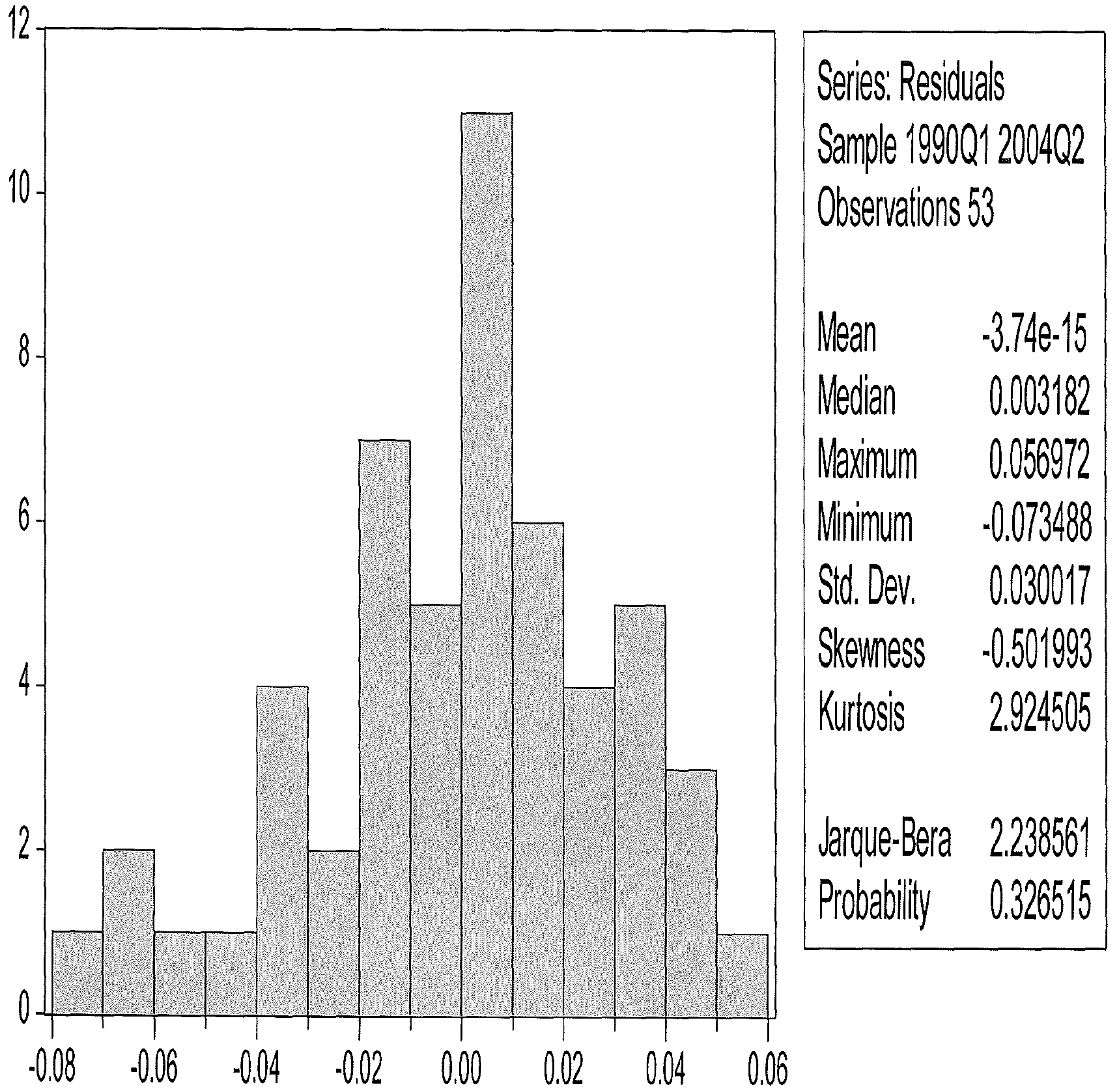
4.5 Diagnostic checks

The results of the diagnostic checks are presented in table 4.6. The results reveal that a Jacque-Bera value of 2.238 with a corresponding p-value of is 0.326 confirming that the residuals are normally distributed. This is also confirmed by the bell-shaped nature of histogram of the normality tests in Figure 4.1. The Ramsey-reset test results indicate that the model is stable with no error specification. The results conclude that there is no autoregressive conditional heteroscedasticity, and therefore accepts the null hypothesis. The test shows that our model is stable and conforms to CLRM assumption.

Table 4.7: Diagnostic test results

Test	H_0	Test Statistics	p-value	Conclusion
Jacque-Bera	Residuals are normally distributed	J.B = 2.238	0.326	*Cannot reject H_0 and conclude that the residuals are normally distributed.*
Ramsey Reset test	Model is stable with no error specification	LR = 0.814	0.3667	*Cannot accept H_0*
ARCH LM	No autoregressive conditional heteroscedasticity up to the 1st order	nR^2 = 66.708	0.0000	*Cannot accept H_0 and conclude that there is no autoregressive conditional heteroscedasticity*
Breusch-Pagan-Godfrey	No heteroscedasticity	nR^2 = 12.558	0.0057	*Accept H0 and conclude that the model is stable.*

Figure 4.1: Histogram of the Normality tests



4.6 Stability tests

Figure 4.2 and Figure 4.3 represent the stability tests performed by means of CUSUM test and CUSUM Sum of Squares. This option plots the cumulative sum together with the 5% critical lines. The test finds no parameter instability because the cumulative sum does not go outside the area between the two critical lines. The movement is inside the critical line which suggests that there is no coefficient instability. Movement within the critical lines is suggestive of no parameter or variance instability.

Figure 4.2: CUSUM Test

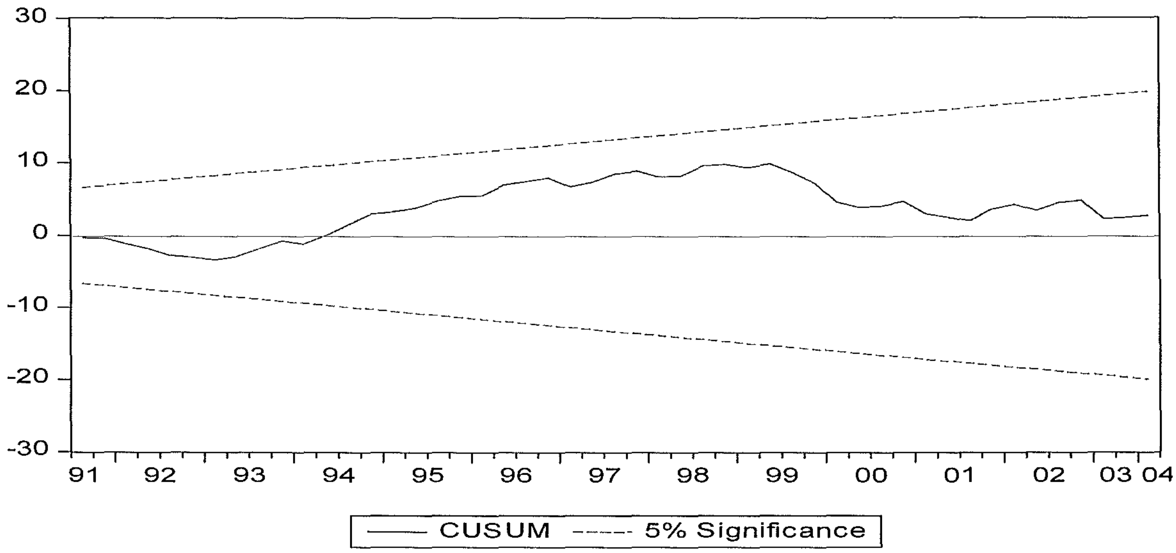
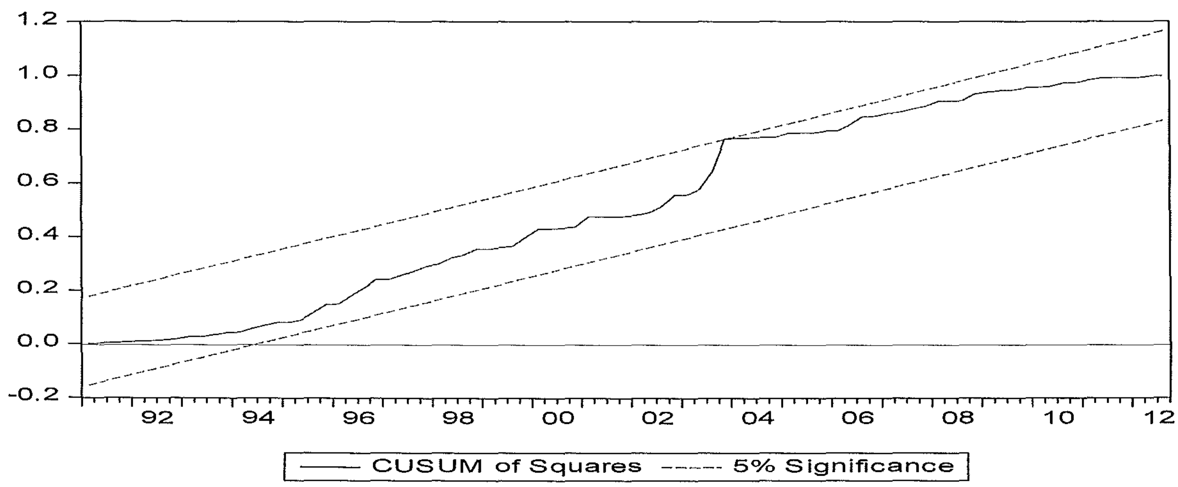


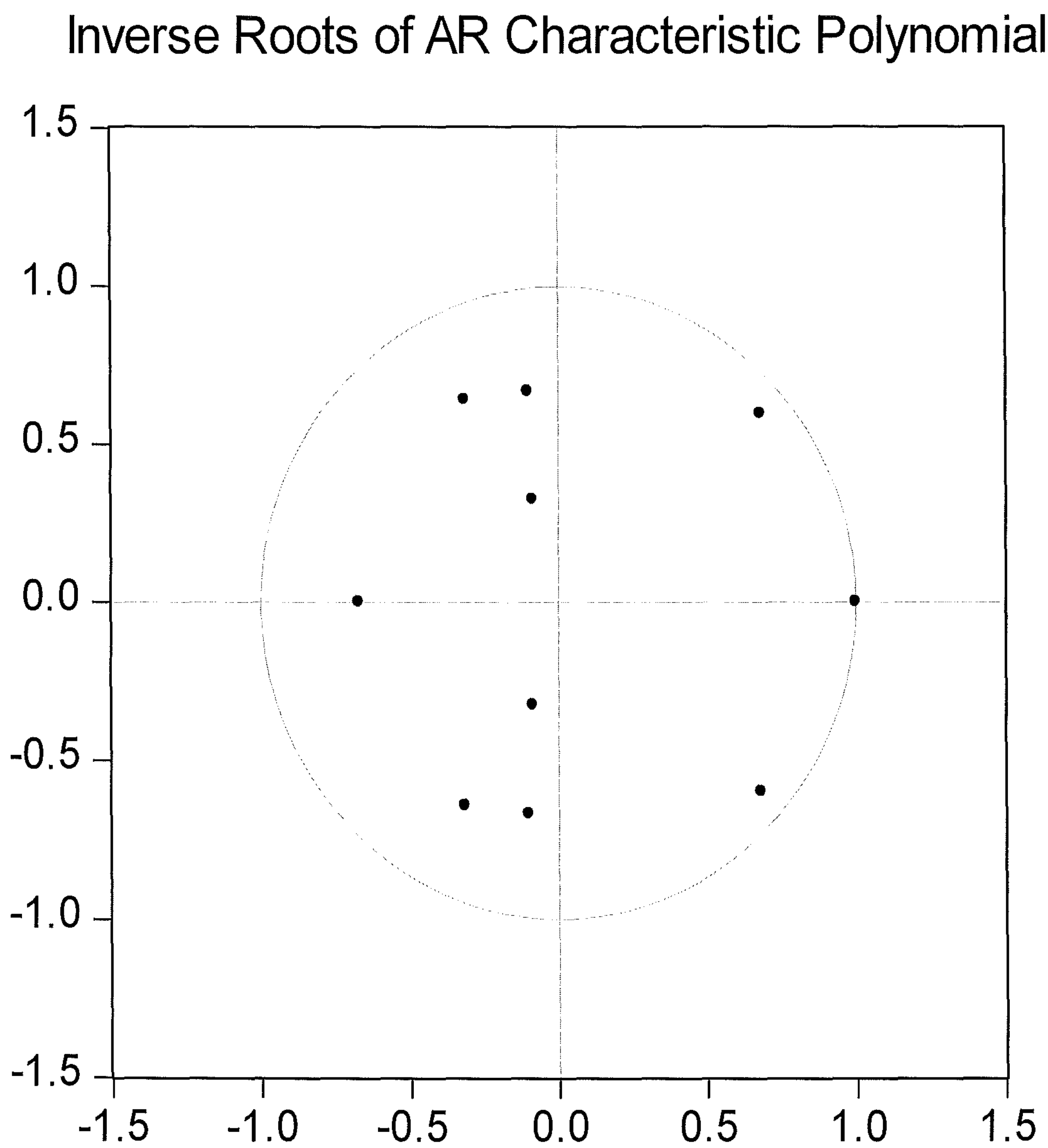
Figure 4.3: CUSUM of Squares



4.7 Inverse Roots of AR Characteristic Polynomial

The VAR model was further taken through the VAR stability condition check and the results are presented in Figure 4.4. In addition the table of Roots of Characteristic Polynomial are in Appendix? Based on Figure 4.4 we concluded that no root lies outside the unit circle, thus the VAR satisfies the stationarity condition because the estimated AR is stationary.

Figure 4.4: Inverse roots of AR characteristic polynomial.



4.8 Variance Decomposition

The results summarized in Table 4.7 analyses the variance decomposition of all variables. The crux of the variance decomposition is that it measures the proportion of forecast error variance in one variable explained by innovations in itself and other variables. But it should be noted that the CVAR was estimated with the sets of simultaneous structural restrictions specified in equations.

Table 4.8: Variance Decomposition of log_gdp

Quarter	log_gdp	lcpi	log_oil	xrate
Variance decompositions for lcpi				
1	5.519384	94.48062	0.000000	0.000000
4	3.459506	72.09301	4.175747	20.27173
8	2.602572	51.51143	15.94085	29.94515
12	2.603705	50.16153	18.12319	29.11157
Variance decompositions for log_oil				
1	3.825664	0.137678	96.03666	0.000000
4	2.613518	0.343487	94.82413	2.218864
8	5.443248	4.753596	86.40368	3.399477
12	7.498821	8.105785	77.94052	6.454872
Variance decompositions for xrate				
1	0.313368	0.990066	10.48932	88.20725
4	0.383032	2.847196	17.05586	79.71391
8	0.505137	3.113754	18.06415	78.31696
12	0.625934	3.472148	18.10814	77.79378

Inflation

The inflationary effects of oil price shocks on the South African economy can be explained by the use of AD-AS model. Increasing inflation contributes to increased levels of economic growth. Inflation rate changes contributed about 5% to changes in economic growth in the 1st quarter, declining through to 3% in the 4th quarter. By the 8th & 10th quarter the inflation rate had farther decreased to 2% for both the 8th and 12th quarter respectively.

Real oil prices

The results show that in the 1st quarter economic growth contributed about 3% to oil price shocks, declining to 2% in the 4th quarter, thus steadily increasing to 5% and 7% in the 8th and 12th quarter respectively

Real exchange rate

The variance decomposition suggests that shocks to economic growth as presented in table 4.7 accounted for about 31% of shocks to real exchange rate in the 1st quarter increasing in effects to about 38% in the 4th quarter, and further increased to 50% and 62% in the 8th and 12th quarter respectively.

4.9 Generalised Impulse Response Function

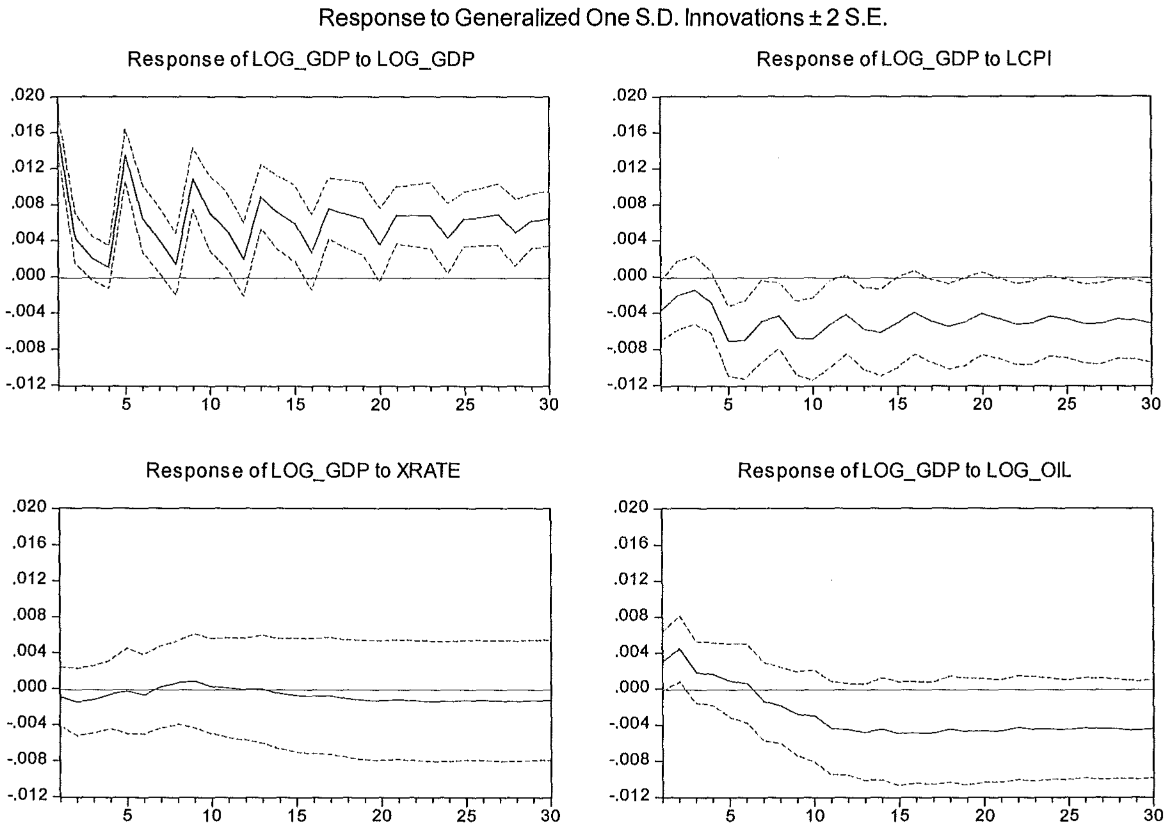
Findings on the generalized impulse response for up to 30 months as shown in Figure 4.5 exposes that the shocks in (LOG_GDP) economic growth have a direct positive effect on economic growth rate. The positive impact persisted throughout the forecast period, the magnitude of the effect continued to increase gradually from the 5th quarter, steadily declined and remained constant until the 30th quarter.

On the contrary, the shocks in (LOG_GDP) economic growth have a negative effect on (LCPI) inflation rate. The negative effect began from the 1st quarter and continued to the last quarter. Although the negative effect persisted throughout the forecast period, the extent of the effect gradually remained constant all the way through the last period. This rate hovered around one percentage point below the equilibrium value. This impact suggests the effect on inflation is transient through the effect of level of consumer prices is permanent.

Similarly, the impact of a shock in (LOG_GDP) economic growth rate on (XRATE) real effective exchange rate suggests that price shock effects in the second quarter imposes a negative impact the exchange rate. The response increases by the 9th quarter, drops again by the 15th quarter and remains steady until the last quarter.

Lastly, a shock of (LOG_GDP) Economic growth to (LOG_OIL) oil price. It is seen that an oil price shock has an immediate effect on economic growth. The impulse response suggests that economic growth increases from the 1st to the 2nd quarter, and then sharply declines from the 7th quarter to the 30th quarter.

Figure 4.5 Generalised Impulse Response Function (GIRF)



4.10 Conclusion

This study used the co-integration analysis and generalized impulse response functions to empirically asses to what extent oil price increases affect economic growth and the volatile exchange rate in South Africa. The analysis lead to the finding that a percentage change in oil prices contributes to the appreciation (depreciation) of the exchange rate by 0.07 in the long run, whereas it leads to a 11.85 (decline) increase. Similarly a percentage increase in the rate of inflation leads to a decrease (increase) of 0.03% in economic growth. The R^2 of the equation further suggests that the model is a good fit with 89%.

CHAPTER 5

CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Introduction

The previous chapter analysed the data collected from several sources. In this final chapter the following are discussed: introduction, conclusion and lastly the policy recommendations on the econometric approaches to the impacts of oil price fluctuations in South Africa.

5.2 Conclusion

This paper studied the economic growth (log_gdp) of South Africa in response to the changing exchange rate, inflation rate and oil prices. The research results indicate that there is a positive long run relationship between oil prices, economic growth and other macroeconomic variables (inflation and exchange rates). The methods of testing for stationarity were examined using ADF and KPSS test. This was followed by testing for cointegration and estimation of the long run cointegration of vectors using the Johansen test of cointegration. In the examining of the short run analysis an Error Correction Model was carried out, followed by a Variance decomposition test and the Generalized Impulse Response Function.

5.3 Recommendations

The South African economy is very vulnerable to oil price shocks. The country's domestic currency keeps depreciating over the entire observed period of the study. This has become a bothersome factor and calls for intervention by monetary authorities and policy makers alike to ensure proper policy measures are undertaken. Increased transparency will better inform policy makers and consumers alike in the legislative and executive branches about elements that affect the volatility and level of prices for oil products.

Generally, it can be said that a fundamental relationship between oil price fluctuations, economic growth and other macroeconomic variables (inflation and the exchange rate) exists. This is strengthened by the conclusion that oil prices have considerable effects on economic growth, inflation and exchange rates. Particularly that oil consumption continues to increase in South Africa, policy makers have to reflect on all the variables as oil price shocks are a substantial source of volatility for many variables in the model.

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APPENDICES

Appendix 1 Johansen Cointegration output

Date: 08/06/14 Time: 13:58
Sample (adjusted): 1990Q4 2003Q2
Included observations: 51 after adjustments
Trend assumption: Linear deterministic trend
Series: LOG_GDP LOG_CPI LOG_OIL XRATE
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.433599	58.44911	47.85613	0.0037
At most 1	0.360665	29.45799	29.79707	0.0547
At most 2	0.095706	6.644303	15.49471	0.6193
At most 3	0.029243	1.513657	3.841466	0.2186

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 *	0.433599	28.99113	27.58434	0.0328
At most 1 *	0.360665	22.81369	21.13162	0.0287
At most 2	0.095706	5.130646	14.26460	0.7252
At most 3	0.029243	1.513657	3.841466	0.2186

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):

LOG_GDP	LOG_CPI	LOG_OIL	XRATE
15.03653	2.927351	-2.926982	0.131103
9.571258	3.370788	-0.985745	-0.383005
34.08846	-0.819819	-19.24454	-0.036525
8.118900	-0.891719	-12.95216	0.037582

Unrestricted Adjustment Coefficients (alpha):

D(LOG_GDP)	-0.007295	-0.005402	-0.001012	-0.003083
D(LOG_CPI)	-0.144303	0.040403	0.013437	0.014056
D(LOG_OIL)	-0.000523	-0.006240	0.008292	-0.001115
D(XRATE)	0.162172	2.342737	0.844863	-0.400770

1 Cointegrating Equation(s):	Log likelihood	86.74104

Normalized cointegrating coefficients (standard error in parentheses)

LOG_GDP	LOG_CPI	LOG_OIL	XRATE
1.000000	0.194683	-0.194658	0.008719
	(0.05349)	(0.12912)	(0.00478)

Adjustment coefficients (standard error in parentheses)

D(LOG_GDP)	-0.109696
	(0.05178)
D(LOG_CPI)	-2.169823
	(0.47183)
D(LOG_OIL)	-0.007863
	(0.06924)
D(XRATE)	2.438510
	(12.4709)

2 Cointegrating Equation(s): Log likelihood 98.14788

Normalized cointegrating coefficients (standard error in parentheses)

LOG_GDP	LOG_CPI	LOG_OIL	XRATE
1.000000	0.000000	-0.307970	0.068961
		(0.26846)	(0.01347)
0.000000	1.000000	0.582035	-0.309438
		(1.11758)	(0.05609)

Adjustment coefficients (standard error in parentheses)

D(LOG_GDP)	-0.161398	-0.039564
	(0.05951)	(0.01490)
D(LOG_CPI)	-1.783115	-0.286237
	(0.54788)	(0.13723)
D(LOG_OIL)	-0.067585	-0.022563
	(0.08022)	(0.02009)
D(XRATE)	24.86145	8.371605
	(13.2668)	(3.32297)

3 Cointegrating Equation(s): Log likelihood 100.7132

Normalized cointegrating coefficients (standard error in parentheses)

LOG_GDP	LOG_CPI	LOG_OIL	XRATE
1.000000	0.000000	0.000000	0.167321
			(0.03253)
0.000000	1.000000	0.000000	-0.495328
			(0.09072)
0.000000	0.000000	1.000000	0.319379
			(0.06369)

Adjustment coefficients (standard error in parentheses)

D(LOG_GDP)	-0.195905	-0.038734	0.046159
	(0.12828)	(0.01514)	(0.06500)
D(LOG_CPI)	-1.325055	-0.297253	0.123950
	(1.17965)	(0.13920)	(0.59771)
D(LOG_OIL)	0.215085	-0.029362	-0.151899
	(0.16579)	(0.01956)	(0.08400)
D(XRATE)	53.66152	7.678970	-19.04301
	(28.1781)	(3.32502)	(14.2775)

Appendix 2 VAR output

Vector Autoregression Estimates
Date: 09/26/14 Time: 13:10
Sample (adjusted): 1991Q1 2013Q4
Included observations: 92 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LOG_GDP	LXRATE	LCPI	LOG_OIL
LOG_GDP(-1)	0.180635	5.522647	-1.525643	-0.275068
	(0.07863)	(7.58688)	(1.99413)	(0.66834)
	[2.29727]	[0.72792]	[-0.76507]	[-0.41157]
LOG_GDP(-2)	0.071283	2.672052	3.808456	-0.449598
	(0.07983)	(7.70285)	(2.02461)	(0.67856)
	[0.89292]	[0.34689]	[1.88108]	[-0.66258]
LOG_GDP(-3)	0.012738	0.278665	-3.312042	1.148770
	(0.08157)	(7.87072)	(2.06874)	(0.69335)
	[0.15615]	[0.03541]	[-1.60100]	[1.65685]
LOG_GDP(-4)	0.771954	-6.273628	-1.279645	0.296883
	(0.07961)	(7.68130)	(2.01895)	(0.67666)
	[9.69687]	[-0.81674]	[-0.63382]	[0.43875]
LXRATE(-1)	-0.001901	0.190800	-0.008677	0.000540
	(0.00113)	(0.10906)	(0.02867)	(0.00961)
	[-1.68206]	[1.74943]	[-0.30268]	[0.05624]
LXRATE(-2)	-0.001139	-0.095977	-0.018539	0.013727
	(0.00115)	(0.11072)	(0.02910)	(0.00975)
	[-0.99251]	[-0.86682]	[-0.63703]	[1.40736]
LXRATE(-3)	-0.000897	0.227387	-0.022382	0.008830
	(0.00116)	(0.11202)	(0.02944)	(0.00987)
	[-0.77300]	[2.02989]	[-0.76017]	[0.89483]
LXRATE(-4)	-0.000146	-0.125873	-0.074557	-0.007363
	(0.00110)	(0.10598)	(0.02786)	(0.00934)
	[-0.13335]	[-1.18769]	[-2.67650]	[-0.78871]
LCPI(-1)	-0.001764	-0.428717	1.158950	0.026405
	(0.00438)	(0.42257)	(0.11107)	(0.03722)
	[-0.40278]	[-1.01455]	[10.4346]	[0.70933]
LCPI(-2)	-0.000923	0.884282	-0.465001	-0.081287
	(0.00668)	(0.64457)	(0.16942)	(0.05678)
	[-0.13819]	[1.37189]	[-2.74467]	[-1.43157]
LCPI(-3)	-0.002381	-0.784783	-0.092382	0.091854
	(0.00656)	(0.63284)	(0.16634)	(0.05575)
	[-0.36309]	[-1.24009]	[-0.55539]	[1.64765]
LCPI(-4)	-0.005929	0.278729	0.140852	-0.075550
	(0.00423)	(0.40767)	(0.10715)	(0.03591)
	[-1.40338]	[0.68371]	[1.31451]	[-2.10373]
LOG_OIL(-1)	0.035317	-0.654518	0.884689	1.026578
	(0.01341)	(1.29413)	(0.34015)	(0.11400)

	[2.63316]	[-0.50576]	[2.60090]	[9.00492]
LOG_OIL(-2)	-0.023853	0.385021	-1.011317	-0.409113
	(0.01895)	(1.82879)	(0.48068)	(0.16110)
	[-1.25848]	[0.21053]	[-2.10394]	[-2.53948]
LOG_OIL(-3)	0.009817	-4.412927	0.758150	0.233959
	(0.01905)	(1.83812)	(0.48313)	(0.16192)
	[0.51535]	[-2.40079]	[1.56925]	[1.44488]
LOG_OIL(-4)	-0.032500	4.109551	0.021916	-0.078395
	(0.01363)	(1.31489)	(0.34560)	(0.11583)
	[-2.38491]	[3.12540]	[0.06341]	[-0.67680]
C	-0.388439	-26.37511	27.56698	-8.298310
	(0.34804)	(33.5816)	(8.82657)	(2.95826)
	[-1.11608]	[-0.78540]	[3.12318]	[-2.80513]
R-squared	0.995628	0.222260	0.818075	0.972142
Adj. R-squared	0.994695	0.056342	0.779264	0.966200
Sum sq. resids	0.018415	171.4399	11.84387	1.330402
S.E. equation	0.015669	1.511908	0.397389	0.133187
F-statistic	1067.408	1.339578	21.07857	163.5795
Log likelihood	261.2121	-159.1748	-36.24335	64.32781
Akaike AIC	-5.308958	3.829886	1.157464	-1.028865
Schwarz SC	-4.842975	4.295869	1.623447	-0.562883
Mean dependent	12.78314	-0.451678	1.812688	3.566840
S.D. dependent	0.215133	1.556388	0.845823	0.724435

Determinant resid covariance (dof adj.)	1.36E-06
Determinant resid covariance	6.02E-07
Log likelihood	136.6848
Akaike information criterion	-1.493148
Schwarz criterion	0.370783

Appendix 3 VECM output

Vector Error Correction Estimates
Date: 09/26/14 Time: 15:18
Sample (adjusted): 1991Q2 2013Q4
Included observations: 91 after adjustments
Standard errors in ( ) & t-statistics in [ ]

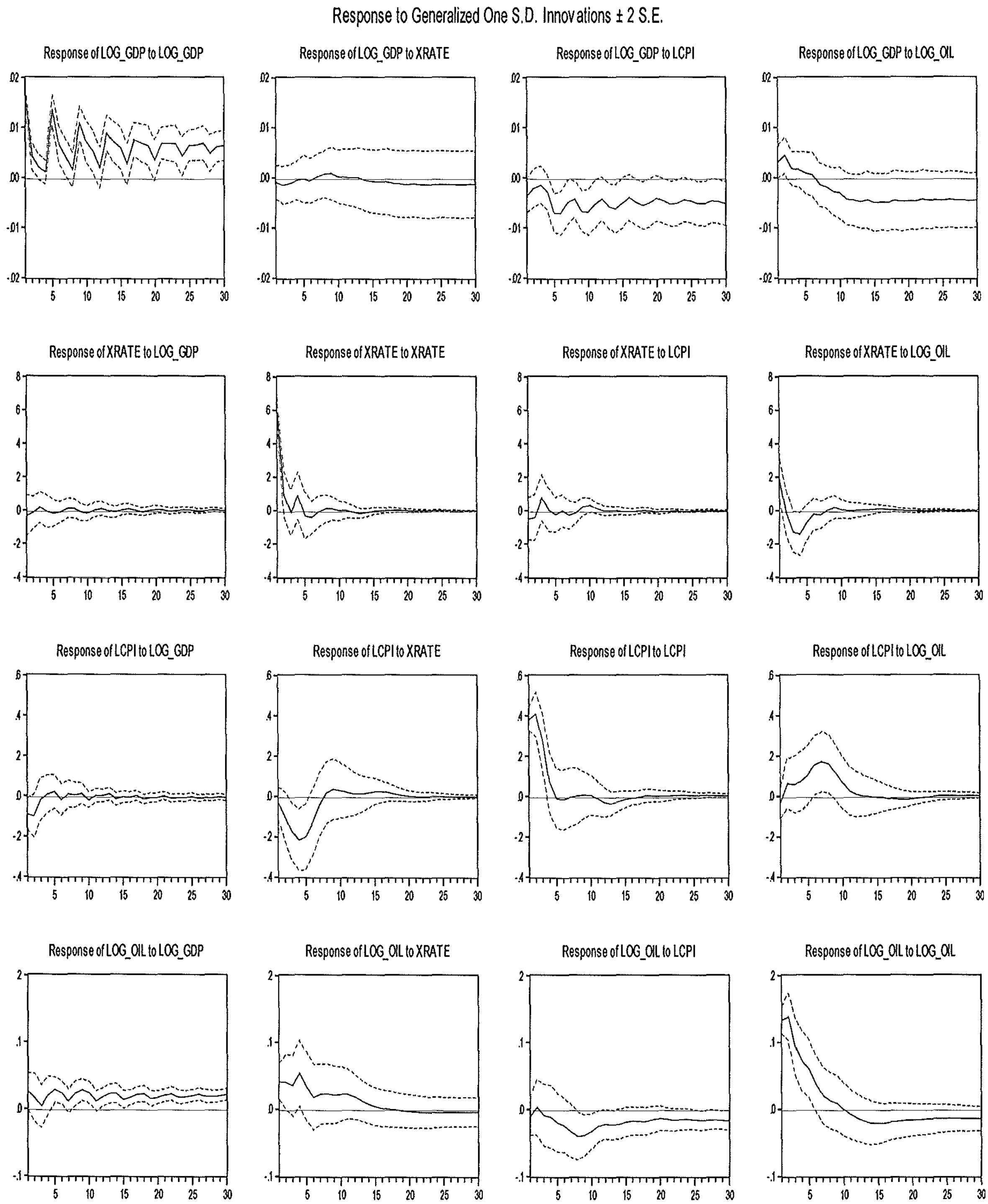
Cointegrating Eq:	CointEq1
LOG_GDP(-1)	1.000000
XRATE(-1)	0.041690 (0.00799) [5.21659]
LCPI(-1)	0.200062 (0.04277) [4.67737]
LOG_OIL(-1)	-0.291587 (0.02951) [-9.88232]
C	-12.05112

Error Correction:	D(LOG_GDP)	D(XRATE)	D(LCPI)	D(LOG_OIL)
CointEq1	-0.001438 (0.01042) [-0.13800]	-4.342382 (6.24358) [-0.69550]	-1.923366 (0.35383) [-5.43586]	0.145352 (0.13189) [1.10208]
D(LOG_GDP(-1))	-0.224655 (0.07350) [-3.05658]	13.94209 (44.0390) [0.31659]	-3.559470 (2.49573) [-1.42622]	0.543306 (0.93027) [0.58403]
D(LOG_GDP(-2))	-0.166831 (0.07640) [-2.18357]	57.12069 (45.7792) [1.24774]	0.768324 (2.59435) [0.29615]	0.668596 (0.96703) [0.69139]
D(LOG_GDP(-3))	-0.154385 (0.07534) [-2.04909]	65.16404 (45.1442) [1.44346]	-0.882971 (2.55836) [-0.34513]	2.174879 (0.95362) [2.28066]
D(LOG_GDP(-4))	0.761415 (0.07630) [9.97937]	23.71993 (45.7168) [0.51885]	-3.073696 (2.59081) [-1.18638]	1.792255 (0.96571) [1.85589]
D(XRATE(-1))	-0.000216 (0.00044) [-0.49702]	-0.525493 (0.26091) [-2.01407]	0.055309 (0.01479) [3.74061]	-0.006738 (0.00551) [-1.22246]
D(XRATE(-2))	-0.000141 (0.00039) [-0.36446]	-0.397688 (0.23195) [-1.71455]	0.043870 (0.01314) [3.33748]	-0.003530 (0.00490) [-0.72055]
D(XRATE(-3))	6.97E-06 (0.00031) [0.02254]	-0.009806 (0.18515) [-0.05296]	0.022469 (0.01049) [2.14137]	0.001346 (0.00391) [0.34417]

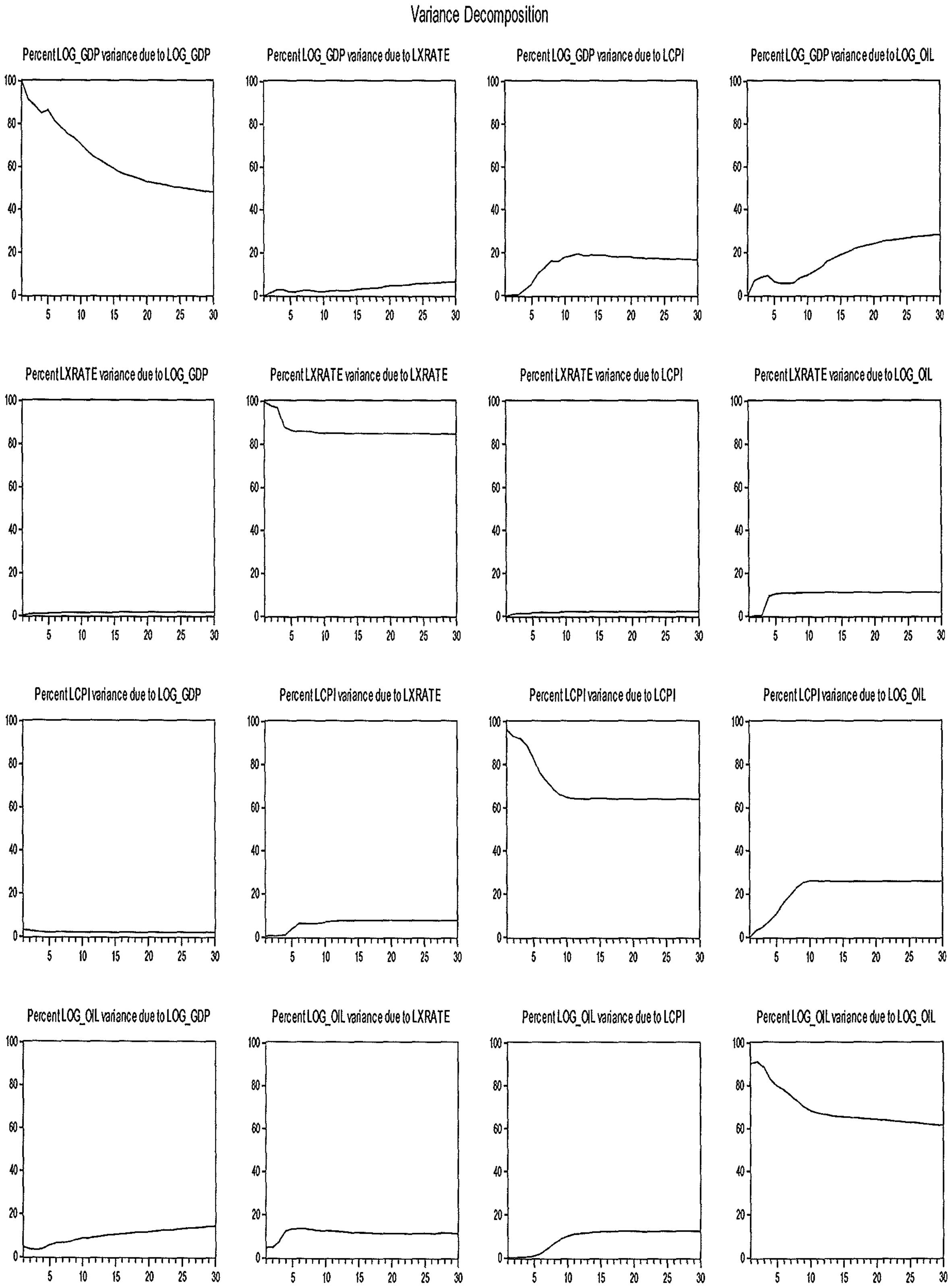
D(XRATE(-4))	0.000144	-0.048879	0.014063	-0.000683
	(0.00022)	(0.12888)	(0.00730)	(0.00272)
	[0.66948]	[-0.37926]	[1.92550]	[-0.25099]
D(LCPI(-1))	0.001761	-0.364595	0.370211	0.012757
	(0.00284)	(1.70066)	(0.09638)	(0.03592)
	[0.62050]	[-0.21438]	[3.84124]	[0.35511]
D(LCPI(-2))	0.001887	3.306831	-0.096570	-0.058958
	(0.00299)	(1.78861)	(0.10136)	(0.03778)
	[0.63199]	[1.84883]	[-0.95273]	[-1.56047]
D(LCPI(-3))	-0.002226	0.431299	-0.020954	0.057231
	(0.00301)	(1.80341)	(0.10220)	(0.03809)
	[-0.73944]	[0.23916]	[-0.20503]	[1.50232]
D(LCPI(-4))	-0.000451	-0.391194	-0.187469	-0.080376
	(0.00274)	(1.64121)	(0.09301)	(0.03467)
	[-0.16449]	[-0.23836]	[-2.01560]	[-2.31841]
D(LOG_OIL(-1))	0.023470	-5.173272	0.701990	0.266237
	(0.00935)	(5.60239)	(0.31749)	(0.11834)
	[2.51012]	[-0.92341]	[2.21105]	[2.24969]
D(LOG_OIL(-2))	0.013672	-10.79079	-0.613566	-0.250995
	(0.00961)	(5.75737)	(0.32628)	(0.12162)
	[1.42290]	[-1.87426]	[-1.88052]	[-2.06381]
D(LOG_OIL(-3))	-0.003395	-17.98220	0.358592	-0.073494
	(0.00944)	(5.65467)	(0.32046)	(0.11945)
	[-0.35979]	[-3.18006]	[1.11901]	[-0.61528]
D(LOG_OIL(-4))	-0.005290	-1.145563	-0.338412	-0.124505
	(0.00977)	(5.85615)	(0.33187)	(0.12370)
	[-0.54122]	[-0.19562]	[-1.01970]	[-1.00647]
C	0.005179	-0.468983	0.045289	-0.012994
	(0.00197)	(1.18039)	(0.06689)	(0.02493)
	[2.62916]	[-0.39731]	[0.67703]	[-0.52113]
R-squared	0.872026	0.454687	0.555120	0.262133
Adj. R-squared	0.842224	0.327696	0.451517	0.090301
Sum sq. resids	0.008274	2970.434	9.539810	1.325454
S.E. equation	0.010646	6.378940	0.361500	0.134748
F-statistic	29.26055	3.580475	5.358178	1.525518
Log likelihood	294.2778	-287.7184	-26.50334	63.30084
Akaike AIC	-6.072040	6.719085	0.978095	-0.995623
Schwarz SC	-5.575386	7.215739	1.474749	-0.498969
Mean dependent	0.007301	0.003297	-0.009731	0.018615
S.D. dependent	0.026802	7.779752	0.488120	0.141277

Determinant resid covariance (dof adj.)	8.64E-06
Determinant resid covariance	3.58E-06
Log likelihood	54.08800
Akaike information criterion	0.481582
Schwarz criterion	2.578564

Appendix 4 Generalized Impulse Response Function output



Appendix 5 Variance Decomposition output



Appendix 6 Variance Decomposition output suing table

VARIANCE DECOMPOSITION

Variance Decomposition of LOG_GDP: Period	S.E.	LOG_GDP	LCPI	LOG_OIL	XRATE
1	0.015832	100.0000	0.000000	0.000000	0.000000
2	0.017042	92.51438	0.424603	4.604914	2.456098
3	0.017342	90.76907	0.713478	5.168452	3.348996
4	0.017678	87.73296	2.946508	5.559740	3.760790
5	0.022709	88.66233	4.867062	4.068428	2.402178
6	0.024312	84.58068	9.584384	3.689993	2.144943
7	0.025098	81.94090	11.60303	4.321132	2.134937
8	0.025601	79.07659	13.67720	4.963313	2.282891
9	0.028759	77.00351	13.00301	7.134469	2.859013
10	0.030511	73.77302	14.64406	8.693615	2.889304
11	0.031780	70.63798	15.18124	11.13332	3.047458
12	0.032511	67.86159	15.89077	13.12616	3.121479

Variance Decomposition of LCPI: Period	S.E.	LOG_GDP	LCPI	LOG_OIL	XRATE
1	0.382601	5.519384	94.48062	0.000000	0.000000
2	0.577713	5.325026	88.34687	3.022983	3.305116
3	0.672061	3.997888	82.55316	3.499961	9.948990
4	0.724729	3.459506	72.09301	4.175747	20.27173
5	0.773689	3.121191	63.26003	5.514094	28.10468
6	0.816075	2.856964	56.92072	8.972206	31.25011
7	0.841155	2.703510	53.57703	12.75816	30.96131
8	0.857880	2.602572	51.51143	15.94085	29.94515
9	0.866005	2.575498	50.56683	17.47151	29.38616
10	0.869389	2.608145	50.17502	18.05376	29.16307
11	0.869972	2.605685	50.11959	18.13276	29.14197
12	0.870533	2.603705	50.16153	18.12319	29.11157

Variance Decomposition of LOG_OIL: Period	S.E.	LOG_GDP	LCPI	LOG_OIL	XRATE
1	0.133463	3.825664	0.137678	96.03666	0.000000
2	0.192721	2.578993	0.201431	97.19775	0.021822
3	0.214779	2.105127	0.297347	97.53349	0.064031
4	0.228905	2.613518	0.343487	94.82413	2.218864
5	0.238035	3.861160	0.641850	92.94693	2.550055
6	0.242247	4.707275	1.225309	91.52112	2.546291
7	0.245616	4.765867	2.850657	89.51572	2.867752

8	0.250124	5.443248	4.753596	86.40368	3.399477
9	0.254698	6.478811	6.255590	83.33589	3.929714
10	0.258640	7.148932	7.221514	80.87416	4.755397
11	0.261466	7.186598	7.826189	79.32198	5.665228
12	0.264582	7.498821	8.105785	77.94052	6.454872

Variance Decomposition of XRATE: Period	S.E.	LOG_GDP	LCPI	LOG_OIL	XRATE
1	6.015008	0.313368	0.990066	10.48932	88.20725
2	6.115625	0.345278	1.478350	10.18879	87.98758
3	6.319954	0.413096	3.137236	13.64513	82.80453
4	6.635920	0.383032	2.847196	17.05586	79.71391
5	6.682025	0.432848	2.990897	17.92498	78.65128
6	6.696591	0.446584	2.979062	17.94783	78.62652
7	6.708646	0.481899	3.094024	18.07908	78.34500
8	6.711434	0.505137	3.113754	18.06415	78.31696
9	6.721314	0.529482	3.218833	18.15105	78.10063
10	6.731018	0.588759	3.406078	18.12950	77.87566
11	6.733546	0.592736	3.470619	18.11653	77.82011
12	6.735122	0.625934	3.472148	18.10814	77.79378

Cholesky Ordering: LOG_GDP LCPI LOG_OIL XRATE

Appendix 7 Roots of Characteristic Polynomial output

Roots of Characteristic Polynomial
Endogenous variables: LOG_GDP LOG_CPI LOG_OIL XRATE
Exogenous variables:
Lag specification: 1 2
Date: 08/06/14 Time: 14:00

Root	Modulus
1.000000	1.000000
1.000000 - 3.76e-16i	1.000000
1.000000 + 3.76e-16i	1.000000
0.682990 - 0.598830i	0.908335
0.682990 + 0.598830i	0.908335
-0.314928 - 0.642739i	0.715747
-0.314928 + 0.642739i	0.715747
-0.101745 - 0.667748i	0.675455
-0.101745 + 0.667748i	0.675455
-0.672027	0.672027
-0.085085 - 0.324780i	0.335740
-0.085085 + 0.324780i	0.335740

VEC specification imposes 3 unit root(s).

Dependent Variable: LOG_GDP
Method: Least Squares
Date: 10/14/14 Time: 17:13
Sample: 1990Q1 2013Q4
Included observations: 96

Variable	Coefficient	Std. Error	t-Statistic	Prob.
XRATE	-0.000662	0.001222	-0.541320	0.5896
LCPI	-0.031152	0.009130	-3.411941	0.0010
LOG_OIL	0.275557	0.010694	25.76858	0.0000
C	11.85095	0.045863	258.3993	0.0000

R-squared	0.893689	Mean dependent var	12.77186
Adjusted R-squared	0.890222	S.D. dependent var	0.217474
S.E. of regression	0.072055	Akaike info criterion	-2.381995
Sum squared resid	0.477659	Schwarz criterion	-2.275147
Log likelihood	118.3358	Hannan-Quinn criter.	-2.338805
F-statistic	257.7952	Durbin-Watson stat	0.444595
Prob(F-statistic)	0.000000		

Appendix 8 Heteroscedasticity output

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	4.615614	Prob. F(3,92)	0.0047
Obs*R-squared	12.55868	Prob. Chi-Square(3)	0.0057
Scaled explained SS	11.75502	Prob. Chi-Square(3)	0.0083

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 09/26/14 Time: 14:54
Sample: 1990Q1 2013Q4
Included observations: 96

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.008743	0.004306	2.030499	0.0452
XRATE	5.92E-05	0.000115	0.515748	0.6073
LCPI	0.002076	0.000857	2.421505	0.0174
LOG_OIL	-0.002124	0.001004	-2.116012	0.0370

R-squared	0.130820	Mean dependent var	0.004976
Adjusted R-squared	0.102477	S.D. dependent var	0.007141
S.E. of regression	0.006765	Akaike info criterion	-7.113271
Sum squared resid	0.004211	Schwarz criterion	-7.006423
Log likelihood	345.4370	Hannan-Quinn criter.	-7.070081
F-statistic	4.615614	Durbin-Watson stat	0.792210
Prob(F-statistic)	0.004707		

Appendix 9 Serial correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	41.43812	Prob. F(4,88)	0.0000
Obs*R-squared	62.70772	Prob. Chi-Square(4)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 09/26/14 Time: 16:26
Sample: 1990Q1 2013Q4
Included observations: 96
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
XRATE	-0.002161	0.000782	-2.763299	0.0070
LCPI	0.005634	0.005931	0.950022	0.3447
LOG_OIL	-0.000853	0.006471	-0.131892	0.8954
C	-0.009534	0.027693	-0.344267	0.7315
RESID(-1)	0.757249	0.100510	7.534044	0.0000
RESID(-2)	0.229548	0.127126	1.805673	0.0744
RESID(-3)	-0.270471	0.125910	-2.148136	0.0345
RESID(-4)	0.132127	0.106253	1.243512	0.2170

R-squared	0.653205	Mean dependent var	-1.08E-15
Adjusted R-squared	0.625619	S.D. dependent var	0.070908
S.E. of regression	0.043386	Akaike info criterion	-3.357684
Sum squared resid	0.165650	Schwarz criterion	-3.143989
Log likelihood	169.1688	Hannan-Quinn criter.	-3.271305
F-statistic	23.67893	Durbin-Watson stat	1.953873
Prob(F-statistic)	0.000000		

Appendix 10 Ramsey Reset output

Ramsey RESET Test
Equation: UNTITLED
Specification: LOG_GDP XRATE LCPI LOG_OIL C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.880696	91	0.3808
F-statistic	0.775625	(1, 91)	0.3808
Likelihood ratio	0.814774	1	0.3667

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.004037	1	0.004037
Restricted SSR	0.477659	92	0.005192
Unrestricted SSR	0.473623	91	0.005205

LR test summary:

	Value	df
Restricted LogL	118.3358	92
Unrestricted LogL	118.7432	91

Unrestricted Test Equation:
Dependent Variable: LOG_GDP
Method: Least Squares
Date: 09/26/14 Time: 14:53
Sample: 1990Q1 2013Q4
Included observations: 96

Variable	Coefficient	Std. Error	t-Statistic	Prob.
XRATE	0.003610	0.005002	0.721650	0.4724
LCPI	0.156991	0.213826	0.734200	0.4647
LOG_OIL	-1.416837	1.921685	-0.737289	0.4628
C	-21.58353	37.96373	-0.568530	0.5711
FITTED^2	0.239618	0.272078	0.880696	0.3808

R-squared	0.894587	Mean dependent var	12.77186
Adjusted R-squared	0.889954	S.D. dependent var	0.217474
S.E. of regression	0.072143	Akaike info criterion	-2.369649
Sum squared resid	0.473623	Schwarz criterion	-2.236089
Log likelihood	118.7432	Hannan-Quinn criter.	-2.315662
F-statistic	193.0687	Durbin-Watson stat	0.468468
Prob(F-statistic)	0.000000		

Appendix 11 Data of variables

** Click on the time series code to view a graph*

Code	Unit Of Measure	Description
KBP6006D	R millions	Gross domestic product at market prices (GDP)
KBP5339Q	Percentage	Foreign exchange rate : SA cent per USA dollar Middle rates (R1 = 100 cents)
KBP7172Q	Percentage	Consumer prices: CPI excluding food and non-alcoholic beverages and petrol (All urban areas)
KBP5392Q	Percentage	Real effective exchange rate of the rand: Average for the period - 20 trading partners - Trade in manufactured goods
View all on single Graph		

Date	KBP5339Q Foreign exchange rate : SA cen ...	KBP6006D Gross domestic product at mark ...	KBP7172Q Consumer prices: CPI excluding ...
1990/01	2.1	1087779	
1990/02	-3.2	1086881	
1990/03	2.5	1085968	
1990/04	2.3	1086976	
1991/01	-1.9	1078330	
1991/02	-7.7	1075896	
1991/03	-2.2	1075479	
1991/04	2.3	1073629	
1992/01	-1	1066105	
1992/02	-0.7	1059566	
1992/03	2.7	1047299	
1992/04	-6.5	1038400	
1993/01	-5.1	1047599	
1993/02	-2.2	1059090	
1993/03	-5.4	1074336	
1993/04	-0.1	1082295	
1994/01	-1.7	1080753	
1994/02	-4.8	1092477	
1994/03	0.1	1104765	
1994/04	1.9	1123205	
1995/01	-0.7	1127262	
1995/02	-2.1	1132267	
1995/03	-0.2	1137155	
1995/04	-0.2	1141643	
1996/01	-3	1157662	
1996/02	-12.6	1179346	
1996/03	-3.6	1192729	
1996/04	-3.6	1204041	
1997/01	2.8	1207500	

1997/02	0.9	1214886	
1997/03	-3.7	1217424	
1997/04	-3.4	1219262	
1998/01	-2.9	1220803	
1998/02	-4.1	1222530	
1998/03	-17.1	1219850	
1998/04	7.7	1221029	
1999/01	-5.2	1232258	
1999/02	-0.5	1242065	
1999/03	0.5	1255629	
1999/04	-0.4	1269437	
2000/01	-2.7	1283716	
2000/02	-8.1	1295527	
2000/03	-2.1	1308358	
2000/04	-7.9	1319489	
2001/01	-2.9	1328058	
2001/02	-2.6	1334697	
2001/03	-4	1338242	
2001/04	-17	1348532	
2002/01	-12.5	1366030	
2002/02	10.5	1382572	11
2002/03	0.1	1393913	11.2
2002/04	8.5	1403225	14.5
2003/01	15.3	1416210	5.8
2003/02	7.4	1423126	2
2003/03	4.5	1430849	-4.6
2003/04	10.2	1439103	-9.2
2004/01	-0.6	1460889	-1.4
2004/02	2.8	1481304	1
2004/03	3.4	1505525	1.5
2004/04	5.4	1521602	2.4
2005/01	0.8	1537071	2.7
2005/02	-6.3	1564655	0.7
2005/03	-1.6	1585991	0.4
2005/04	-0.3	1596611	1
2006/01	6.1	1620881	0.5
2006/02	-4.3	1647548	2.2
2006/03	-10	1671028	5.2
2006/04	-2.2	1697027	6.7
2007/01	1	1723976	3.5
2007/02	1.8	1737298	4.4
2007/03	-0.1	1758806	6
2007/04	5.1	1784580	6.2
2008/01	-9.9	1797770	7.9

2008/02	-3.4	1817405	7.7
2008/03	0	1825454	8.8
2008/04	-21.5	1817747	6.7
2009/01	-0.6	1788585	9.6
2009/02	17.8	1776243	8.5
2009/03	8.5	1783768	7.4
2009/04	4	1799004	2.6
2010/01	-0.2	1819387	4.5
2010/02	-0.4	1832882	5.1
2010/03	2.9	1849552	2.7
2010/04	6.1	1870211	3.5
2011/01	-1.3	1893528	2.5
2011/02	3	1903012	6.3
2011/03	-4.5	1911466	4.6
2011/04	-12.1	1929366	4.3
2012/01	4.4	1940989	4.5
2012/02	-4.5	1953619	6
2012/03	-1.8	1959889	4
2012/04	-4.9	1971279	5.4
2013/01	-2.8	1975071	5.8
2013/02	-5.7	1990901	6.2
2013/03	-5.1	1994455	4
2013/04	-1.6	2013305	5.7

Source: South African Reserve Bank