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THE IMPACT OF OIL PRICE VOLATILITY ON ECONOMIC GROWTH IN SOUTH AFRICA: A COINTEGRATION APPROACH

BY

MATEKENYA WELISWA

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SUPERVISOR: PROFESSOR R.NCWADI

CO-SUPERVISOR: MR D.HOMPASHE

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ABSTRACT

Oil is an essential commodity in the South African economy and a source of energy that is used for electricity generation, heating, and cooking. It is vital for the transportation system on which the very livelihood of the economy depends. 14% of South African primary energy needs are met by oil while 95% of crude oil is imported, primarily, from Saudi Arabia and Iran. This study investigates the impact of oil price volatility on economic growth in South Africa from 1994Q1-2010Q4. The study employs the VECM and shows that there exists both a long run and short run relationship between the following variables: crude oil price, GDP, gross fixed investment, real interest rate and real exchange rate. In a long-run analysis there is a positive relationship between oil price and GDP while there is negative relationship in the short-run. The study also shows that, as an oil importing country, South Africa's economic growth depends on imported oil which makes the country vulnerable to oil price shocks. Based on the findings of this study it is recommended that policy interventions should include both monetary and fiscal policies. It is in this regard that promoting a regional integration in order to reduce oil dependence, by optimizing electricity supplies across the region, is essential. This will improve efficiency and, owing to economies of scale, lower generation costs.

Keywords: Crude oil price volatility, Economic growth, South Africa

DECLARATION

I, Weliswa Matekenya, the undersigned, hereby declare that this dissertation is my own original work with the exception of specific sources which are acknowledged throughout and in the reference list. Furthermore, I declare that this dissertation has not previously been submitted, and will not be presented, to any other University for any other degree.

Signature ………………………..

Date ……………………….

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DEDICATION

I dedicate this project to my loving mother, Miss. N. Matekenya, and my wonderful brothers and sisters who are my sources of inspiration. Without you, this journey would have been in vain.

LIST OF ACRONYMS

ACF	Auto-Correlation Function
ADP	Augmented Dickey-Fuller
AFDB	African Development Bank
ASGISA	Acceleration and Shared Growth Initiative for South Africa
CGE	Computable General Equilibrium
CO	Crude Oil
CPI	Consumer Price Index
DF	Dickey-Fuller
DRM	Dynamic Regression Model
DTI	Department of Trade and Industry
GARCH	Generalised Auto-regression Condition Heteroscedasticity
GDP	Gross Domestic Product
GEAR	Growth Employment and Redistribution
GFI	Gross Fixed Investment
GTA	Global Trade Atlas
J-B	Jarque-Bera
LM	Lagrange Multiplier
NGP	New Growth Path
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PP	Philips Peron

RER	Real Exchange Rate
RIR	Real Interest Rate
SA	South Africa
SARB	South African Reserve Bank
SARS	South African Revenue Services
SLR	Simple Linear Regression
TFD	Total Factor Productivity
US	United States
VAR	Vector Auto- regression
VARMA	Vector Auto-regression Moving Average

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CHAPTER ONE

Introduction and Background

1.1Introduction

Oil shocks exert influence over macroeconomic activity through various channels, many of which imply a symmetric effect. However, the effect can also be asymmetric. In particular, sharp oil price changes either increase or decrease the aggregate output temporarily because they delay business investment by raising uncertainty or inducing costly sectorial resource reallocation. Oil is an essential commodity in the South African economy and a source of energy that is used for electricity generation, heating, and cooking; most importantly, it is used as a liquid fuel for the country's transportation system which includes the movement of people and cargo. Approximately 14% of South Africa's primary energy needs are met by oil and 95% of the country's crude oil is imported from Saudi Arabia and Iran. The other sources of oil imports are African countries that include Nigeria, Libya, and Gabon; Europe, the Middle East (Iraq, United Arab Emirates, Yemen and Oman), North America, Russia and South America Lane et al. (2008).

Oil powered cars, trucks, boats, airplanes, and even power plants that constitutes to the backbone of the global economy. Stern and Cleveland (2004) found that oil is the critical input in the production process and is therefore an important factor for economic growth. As oil prices rise, costs accelerate for transportation companies, consequently squeezing their profit margins and forcing them to raise prices. By contrast, most energy companies benefit from higher oil prices, either from higher revenues for oil, or because of increased demand for substitute energy sources such as ethanol and natural gas. The extreme volatility of this important economic input has raised interest in issues like peak oil, speculation, and the world's rising energy appetite; this is leading to greater investment in renewable energy (Wakeford, 2008 and Nkomo, 2006).Oil price shock affects the economies of many nations. The high demand in oil, due to the rapid industrialization in world economies, has led researchers to explore the effect that oil price fluctuation has on economies (Nkomo, 2006). There is a concern that large fluctuations in oil prices are harmful to the economies of oil importers in particular. In this regard, this study examines the relationship between oil price volatility and South Africa's economic growth.

1.2 Problem statement

Since South Africa is an oil importing country, its economic growth depends on imported oil which makes the country vulnerable to oil price shocks. 'Oil price shocks' refers to oil price volatility which emanates from changes in the supply and demand for oil. Increases in oil prices lead to rising domestic import prices. Nkomo (2006) argues that oil price shocks can affect South African economic growth negatively because oil price increases reduce national output, change the structure of spending and production, and they shift the economy toward a lower economic growth trajectory.

According to African Development Bank (AFDB) (2005),crude oil prices have been substantially high. For example, a barrel of crude oil was trading between $18 and $23 in the 1990s; it crossed the $40 mark in 2004 and rose to about $60 in 2005. During the summer of 2007, the price of one barrel of crude oil jumped above $70 and even crossed the US$147 mark in July 2008. In July 2008, oil prices struck an all-time high above $144 a barrel which was seven times higher than $19.70 a barrel in December 2001.The 2008 oil price was the most expensive ever, which led to a large import bill and reduction on output as measured by gross domestic product (GDP) from 3.6% in 2008 to -1.5% in 2009.

According to Wakeford (2008), an increase in oil prices generated increases in inflation, interest rates as well as exchange rates. The impact of increased inflation is that monetary authorities raise interest rates, resulting in decreased consumption, investment and economic growth. Furthermore, a rise in oil prices may lead to increases in the scarcity of energy which has a dampening effect on economic growth. The effect of rising energy prices on South African economy is that they jeopardize the economic growth rate (Wakeford, 2008). When oil prices rise, consumers tend to cut back on discretionary spending, so as to have enough money for the basics, such as food and gasoline for commuting. These cut-backs in spending lead to lay-offs in discretionary sectors of the economy, such as vacation travel and visits to restaurants. The lay-offs in these sectors lead to more cutbacks in spending, and to more debt defaults (AFDB, 2005).

1.3 Objectives

The main objective of this study is to investigate the impact of oil price volatility on economic growth in South Africa. The specific objectives of the study are as follows:

- To analyse the trends of oil prices and gross domestic product in South Africa
- To econometrically evaluate the impact of oil price volatility on economic growth in South Africa during the period 1994 to 2010
- To make policy recommendations based on the findings of the study

1.4 Hypothesis of the study

Ho: Oil price volatility has a negative impact on economic growth in South Africa.

Ha: Oil price volatility does not have a negative impact on economic growth in South Africa.

1.5 Significance of study

There is on-going public and academic discourse as to whether or not oil price volatility leads to negative economic growth in South Africa (Wakeford,2008). The results of previous studies on the impact of oil price volatility on economic growth are inconclusive (Loungani, 1992). The results show that an oil supply shock has a short-lived significant impact, only on the inflation rate, which has a negative impact on the South African economy, while its impact on the other variables is statistically insignificant. Supply disruptions result in a short-term increase in the domestic inflation rate, with no reaction from the monetary policy (Modise et al, 2013). The results of this study will help policy planners to devise effective growth strategies which are informed by scientific research. The South African policy response to inflation resulting from oil price shocks is always followed by controversies from various sectors of the economy. For example, during the oil price hikes in 2008, the policy response from the South African Reserve Bank was condemned as ill-informed because the Reserve Bank continued to increase interest rates in order to curb inflationary pressures, to the detriment of domestic economic activity (South African Good News, 2008).

1.6 Methodology of the study

The study applies the Vector Error Correction Modelling (VECM) approach; this study empirically investigates the impact of oil price volatility on economic growth in South Africa. In testing for the unit root properties of the time series data, the variables were subjected to the Augmented Dickey-Fuller (ADF) and Philips-Peron unit root test. Cointegration and Vector Error correction Modelling (VECM) by Johansen (1995) was employed.

The study makes use of diagnostic tests such as the residual normality test, heteroscedacity, autocorrelation tests and the Ramsey test for misspecification in order to validate the parameter estimation outcomes achieved by the estimated model.

1.7 Organization of the study

Chapter One provides an introduction and background to the study. The problem statement, objectives of the study, hypothesis, significance and methodology of the study are also provided in this chapter. Chapter Two offers a discussion of the theoretical and empirical literature pertaining to the relationship between oil price volatility and economic growth. Chapter Three provides an overview of all the variables and the trends in the link between oil price volatility and economic growth in South Africa between 1994Q1 and 2010Q4. Chapter Four presents a discussion of the methodology employed in this study. Chapter Five presents the methodology and interpretation of the results of the research. Chapter Six presents a summary of the research and the conclusions of study; it also offers policy recommendations based on the research findings.

1.8 Conclusion

This chapter presented the introduction to and background of the study. The research problem was outlined together with the aims and objectives of the study. The method of research to be applied in this study was described and the deployment of the study was outlined herein. Having outlined the conceptual framework of the study in this introductory chapter, the scene is set to present the theoretical framework of the study. The theoretical and empirical literature relevant to this study is provided in the next chapter.

CHAPTER TWO

Literature review

2.1 Introduction

This chapter offers a review of the relevant theoretical and empirical work related to the impact of oil price volatility on South African economic growth. This chapter is divided into three sections: the first section covers the theoretical literature on the impact of oil price volatility in economic growth of South Africa; the second section provides a discussion of the empirical findings on the same subject. The last section offers an assessment of the literature and the concluding remarks pertinent to the work covered in this chapter.

2.2 Theoretical literature

This section examines some of the established theories on economic growth. Various schools of thought have attempted to analyse and asses the relationship between oil prices volatility and economic growth. Examples if these are: transmission channel, Harrod-Domar, the neoclassical growth theory and the endogenous growth theory.

2.2.1 Transmission Channels

In the economy, the transmission channel is that tool capable of transferring the action and effects of a factor or a series of factors over another or others within a country, and from one country to another which was developed by Friedman and Schwartz in 1963. The real balance channel includes income transfer (from oil importers to oil exporters), endogenous monetary policy response and sectoral shifts.

In accordance with a classical supply side channel, crude oil is viewed as a basic input in production. Increases in oil price have an effect on output through the increase in cost of production by changing the domestic capital and labour inputs and reducing capacity utilization. As a result, growth rate and productivity decline. Slowing productivity growth decreases real wage growth and increases the unemployment rate (Brown and Yucel, 2002). High oil prices can increase the marginal cost of production in many industries, thus reducing production and consequently increasing unemployment (Kian, 2008).

Transmission channel involves an income transfer effect which is a transfer of wealth between oil-importing and oil-exporting countries. According to this theory, the increase in oil prices generates a transfer of income from the oil-importing country to the oil-exporting countries. Dohner (1981) emphasizes that the income has an impact on trade balance because the oil-exporting country is consuming less; this increases savings, therefore boosting investment, while oil-importing decreases their investment.

The income transfer emphasizes the shift in purchasing power from oil importing nations to oil exporting nations; oil price increases lead to a transfer from net oil-import economies to oil-exporting countries. The shift in purchasing power parity leads to a reduction in consumer demand for oil importing nations and increases consumer demand in oil exporting nations. Consequently, world consumer demand for goods produced in oil importing nations is reduced and the world supply of savings is increased. Increase in the supply of savings causes real interest rates to decrease. Diminishing the world interest rate should stimulate investment that balances the reduction in consumption and leaves aggregate demand unchanged in oil importing countries (Darby, 1982).

Brown and Yucel (2002) emphasized that, if prices are sticky downward, the reduction in demand for goods produced in oil importing countries will further reduce GDP growth. If the price level cannot fall, consumption spending will fall more than increases in investments thus leading to a fall in aggregate demand and further slowdown economic growth.

Real balance effect is also part of the transmission channel discussed by Mork (1989). According to the real balance effect, an increase in oil prices would lead to an increase in money demand. When monetary authorities fail to increase money supply in order to meet growing money demands, the interest rate will raise the deteriorating growth rate. The real balance channel posits that oil price increases lead to higher inflation, with a given money supply, which lowers the amount of real balances. The lower real balances produce recessions through the familiar monetary channel then increased interest rates leading to depressed investment spending, reduced aggregate demand and a concomitant fall in output.

The sectoral shifts hypothesis postulates that changes in oil prices perform better in explaining observed variations in output growth (Loungani, 1992). Against this backdrop, oil price shocks lead to a temporary improvement in aggregate unemployment since workers in adversely impacted sectors may choose for suffering frictional unemployment pending an improvement in conditions in their sector, rather than outright movement into positively affected sectors of the economy (Hamilton, 1988).

2.2.2 The Harrod-Domar Model

The Harrod-Domar theory, a Keynesian economy, perceives growth as the outcome of equilibrium between savings and investment. The model was developed by Sir Rev. F. Harrod in 1939 and Evsey Domar in 1946. Harrod was from England while Domar, who independently formulated the model, was from the United States of America (USA). The Harrod-Domar model is the precursor to the exogenous growth model. This theory works from the assumption that it is a closed economy and there is no government intervention, and that there is no depreciation on existing capital, so that all investment is net investment and all investment (I) comes from savings (S).

The Harrod-Domar model sees growth as the outcome of the equilibrium between saving and investment. The model suggests that the economy's rate of growth depends on the level of savings and the productivity of investment; for example, the capital output ratio. This model includes the warranted growth and the rate of output growth at which firms believe they have the correct amount of capital and therefore do not increase or decrease the investment. The Harrod-Domar model makes a number of assumptions, some of which are represented mathematically below:

Output is a function of capital stock, i.e.

$Y = f(K)$……………………………………………………………………………2.1

Where,

$Y =$ Gross Domestic Product, and

$K =$ Level of Capital Stock

The production function exhibits constant returns to scale. That is, the marginal product of capital is constant. This implies that the marginal and average products of capital are equal. Mathematically, this assumption is presented as:

$\frac{dY}{dK} = c \Rightarrow \frac{dY}{dK} = \frac{Y}{K}$; (where c is the constant)

The product of the savings rate and output equals saving, which equals investment; this means that

$sY = S = I$…………………………………………………………………………2.2

Where,

s =Savings rate,

S = Level of Saving, and

I =Levels of Investment.

The change in the capital stock is equal to investment less the depreciation of the capital stock, i.e.

$$\Delta K = I - \delta K$$

The equation above is a simplified version of the famous Harrod–Domar equation in the theory of economic growth, implying that the rate of growth of GDP is determined jointly by the saving ratio, S, and national capital/output ratio, k. productivity energy and employment, in regards to the economy, will be inoperative without achieving that rate of growth in national income, or will be used at less than its capacity.

According to the Harrod-Domar model, there are three kinds of growth: warranted growth, actual growth and the natural rate of growth. The actual growth rate is shown as the ratio of saving out of income in relation to the ration of change in capital. According to Harrod (1939),the warranted growth rate is the rate of growth at which the economy does not expand indefinitely or go into recession, that is, a growth that encourages investment. This means that investment and savings are in equilibrium and the capital stock is fully utilised.

There are various weaknesses and strength of the Harrod-Domar model, some of which are outlined in the paragraph below.

There is no reason for growth to be sufficient enough to maintain full employment, as the model maintains. The model explains economic growth in terms of booms and busts. This assertion has been widely refuted, both theoretically and empirically. Economic growth and development are used interchangeably in the Harrod-Domar model; however, critics maintain that these concepts are not necessarily similar.

The strength of the Harrod-Domar model is the fact that, in the short-run, in the absence of economic shocks, it predicts economic growth well. It is also a relatively simple model.

A further weakness of the Harrod-Domar model, as noted by Vane (2000), is the assumption of zero substitutability between capital and labour (that is fixed factor proportions of production function) and this assumption holds true at all times. The main criticism of the model is the level of assumption; one assumption being that there is no reason for growth to be sufficient in order to maintain full employment. This is based on the belief that the relative price of labour and capital is fixed and that they are used in the equal proportions. The model explains economic boom and bust through the assumption that investors are influenced by output; this is now widely believed to be false.

A critique leveled against the Harrod-Doma claims that the model sees economic growth and development the same but, in reality, economic growth is only a subset of development. Another criticism of this model is that it implies that poor countries should borrow to finance investment in capital in order to trigger economic growth. However, the history has shown that this often causes repayment problems later. The most important parameter of the Harrod-Domar model is the rate of saving.

2.1.3 The neoclassical growth theory

The basic neoclassical growth model was originally developed by Robert Solow and Trevor Swan (1956). It is well-known, particularly for its use of the production function. The model entails that the rate of growth of GDP is increased by the higher share increase on investment and decreased by the rate at which the physical capital stock depreciates; moreover, it is increased by the total factor of productivity.

The model assumes that, first, the labour force growth is constant; second, all saving is invested, that is, saving (S), investment (I) and the propensity to save (sY), are all equal; and, third, output, Y, is determined by the interaction of capital and labour, that is, Y = F (K, L). The production function Y = F (K, L) exhibits constant returns to scale and diminishing returns to the variable factor, in the event of other factors being held constant (Mankiw, 2003).

Endogenous growth theory highlights the fact that for productivity to increase, the labour force must continuously be provided with more resources. In this case, resources include physical capital, human capital and knowledge capital (technology). Therefore, growth is driven by the accumulation of factors of production while accumulation is, in turn, the result of investment in the private sector. This implies that the only way a government can affect economic growth, at least in the long run, is via its impact on investments in capital, education as well as research and development (R&D). The reduction of growth in these models occurs when public expenditure deters investments by creating tax wedges beyond what is necessary to finance their investments or by taking away the incentives to save and accumulate capital.

Dornbusch et al. (1999) argue that an increase in the rate of growth of technology or the total factor productivity of the economy results in an increase in output per worker growth. The strength of these effects (the amount by which an increase or decrease affects GDP per worker growth) depends on a parameter which is best interpreted as the “share” of national product that is earned by owners of capital (rather than suppliers of labour) and on the economy’s output to capital ratio (Y/K). If the capital share is multiplied by the output-to-capital ratio, the marginal product of capital (gross of depreciation) is obtained. The neoclassical growth model assumes that technological progress is exogenously determined and its level is the same across countries.

Bernank (1983) argues that once the oil price increases are perceived as permanent, private investments decrease. Moreover, if the shocks are perceived as persistent, oil is used less frequently in production, capital and labour productivity decrease and the potential output falls. The justification is that the return on capital is decreased due to an increase in the proportion of the capital stock to output. This occurs even up to the level of equilibrium which cannot increase the proportion of capital to production beyond. Further, it is not possible to invest in productivity in the long-term, but it will increase and then return temporarily until stability is retained.

This assumption involves an implication that the economy will reach a steady-state level of growth. According to Dornbusch et al. (1999), at the steady-state the per-capita output is constant. The neoclassical growth model has several weaknesses that include the assumption of perfect competitive markets. The inclusion of this assumption was necessary to ensure that all resources were optimally allocated (Nattrass, 1997).

Hamilton (2008) argues that, for a neoclassical economist, the most natural way to think of oil is as an input to the economy’s production function. When an input gets more expensive, the profit-maximizing level of output declines. He continues that any increase in the price of oil can lead to a greater decline in output, through the increase of production cost, and a decline in wages and employment which has a negative effect on economic growth.

Lydall (1998) stresses that, under this assumption, equilibrium will be achieved, thus ensuring the maximum allocation of resources by markets themselves. It has also been argued that neoclassical theorists believe that markets do not fail to clear; this is considered the limitation of this theory. Thus, only minimal government intervention is necessary. Lydall (1998) shows that in real-world situations, markets have to be regulated. In the real world, some groups have power over some markets.

The criticism leveled against the neoclassical growth model has given rise to the endogenous growth theory. The assumption of perfect competition assumes that equilibrium will be achieved, ensuring the maximum allocation of resources by markets. When markets fail to clear, uncertainty emerges and information becomes imperfect. This causes instability in expectations and accrues in markets as investment plans are scaled down. The effect of change in investment plans impacts negatively on economic growth.

The most important weakness in the neo-classical theory is its inability to take internal factors into account in regards to long-term economic growth, focusing on external factors in technology, in addition to the neglect of policies and institutions in economic growth. The weakness of the model is that it explains economic growth using exogenous variables.

2.1.4 Endogenous Growth Model

The endogenous growth theory was developed in the 1980s. The most basic proposition of growth theory is that, in order to sustain a positive growth rate of output per capita in the long run, there must be continual advances in technological knowledge in the form of new goods, new markets, or new processes. The neoclassical growth model, developed by Solow (1956) and Swan (1956), demonstrates this by showing that if there was no technological progress, then the effects of diminishing returns would eventually cause economic growth to cease.

The Solow Growth Model is the most famous neoclassical growth model and is the most common starting point for any analysis of growth in a country. It treats technological growth, as well as the rate of savings in a country, as exogenous (i.e. determined outside the system). It features both labour and capital as factors of production, and assumes constant returns to scale (CRS) for both factors. This is an important assumption; it means that if capital and labour are doubled as inputs, output will also double. The Solow model is a dynamic model that predicts convergence, in the long run, to a steady state rate of growth for a country.

As in the Harrod-Domar model, the aggregate production function can be written as a function of capital alone, i.e.:

$$Y = f(K)$$

This function expresses how much of output Y can be produced, given the aggregate capital stock K, under a given level of technology, with a given range of available techniques, and given different capital endowments, as well as intermediate and consumption goods. The endogenous growth model also assumes that all capital and labor are fully and efficiently employed, so $f(K)$ is not only what can be produced, but also what will be produced. The endogenous growth theory further holds that policy measures can have an impact on the long-run growth rate of an economy. Endogenous growth is long run economic growth at a rate determined by forces that are internal to the economic system, particularly those forces governing the opportunities and incentives for creating technological knowledge.

In the long run, the rate of economic growth, as measured by the growth rate of output per person, depends on the growth rate of total factor productivity (TFP), which is in turn determined by the rate of technological progress. The neoclassical growth theory of Solow (1956) and Swan (1956) assumes the rate of technological progress to be determined by a scientific process that is separate from, and independent of, economic forces. Neoclassical theory thus implies that economists can take the long-run growth rate as given exogenously from outside the economic system.

The endogenous growth model assumes away population growth and technological change; therefore, the only remaining determinant of growth is capital accumulation. Essentially, this means that output will only grow if the capital stock increases.

According to Romer (1990), it is assumed that aggregate productivity is an increasing function of the degree of product variety. In this theory, innovation causes productivity growth by creating new, but not necessarily improved, varieties of products. It makes use of the Dixit–Stiglitz–Ethier production function, in which final output is produced by labour and a continuum of intermediate products.

2.1.4 Assessment of theoretical literature

The growth theories that were reviewed were the Harrod-Domar, neoclassical and endogenous theories. All of these theories use the production function as factors that contribute to economic growth. Harrod-Domar uses output as a function of capital, savings and investment. All these factors contribute to economic growth. The neoclassical growth theory assumes that capital and labour productivity are determinants of economic growth. The endogenous growth theory holds that economic growth is primarily the result of endogenous forces, not external ones. The theory predicts that the economy will reach a steady equilibrium due to the diminishing marginal product of capital and technology. In this regard, any decline in productivity in either capital or labour will result in a decline in the economic performance of the country. It stands to reason, therefore, that fuel or oil price increases are likely to increase the cost of production, thereby reducing productivity levels. It is in this respect that both the Harrod-Domar Model and the neoclassical growth model are relevant to this study.

The transmission channel theory was also discussed; this theory explains the channels which oil price increase or decrease pass through in order to affect the economy, namely, the real balance channel which includes income transfer, endogenous monetary policy response and sectoral shifts. According to this theory, the income transfer channel transfers the wealth of the oil-importing country to an oil-exporting country. This theory also explains that crude oil price is viewed as input in the production function, the decrease or increase of oil price affects the output as it either decreases the output or increases the output through an increase or decrease in the cost of production. This theory is also relevant to this study.

2.2 Empirical review

The impact of oil prices has received a significant degree of attention in many countries. This section discusses the empirical literature based on developed countries, developing countries and South Africa.

2.2.1Developed countries

Rahman and Serletis (2010) investigate the relationship between oil price uncertainty and the level of economic activity, using quarterly Canadian data over the period1974:1 to 2010:1. The study employs the bivariate Vector Auto-regression Moving Average(VARMA) and Generalised Auto-regression Condition (GARCH)-in-Mean model. The model represents a reasonable description of the Canadian data on output growth and the change in the real price of oil. The study shows that the conditional variance covariance process underlying output growth and the change in the real price of oil exhibit significant non-diagonally and asymmetry. The results present evidence that there is increased uncertainty as to whether the change in the real price of oil is associated with a lower average growth rate of real economic activity in Canada. The study also shows results that are robust to alternative measures of the price of oil, alternative measures of the level of economic activity, and alternative data frequencies.

Cologni and Manera (2005) adopted the structural VAR methodology to study the short run and long run impact of oil price changes in regards to the output level, along with other macroeconomic variables (i.e. interest rate, inflation, unemployment and exchange rate), of the G7 countries for the period of 1985 to 2005. They proposed a tight monetary policy for the countries under observation in order to control inflation, in reaction to the unanticipated change in oil prices; this has affected real economic activity adversely by increasing the real cost of doing business.

Rebeca et al. (2004) examines oil prices of real economic activities of the main industrialised countries. Multivariate VAR analysis is carried out using both a linear and nonlinear model. The variables considered for this model are the following: real GDP, real effective rate, real price of oil, real wage, inflation and interest rate. The results show evidence of the non-linear impact of oil prices on real GDP. The results we obtain from vector auto regressions are broadly consistent with the expectation that the real GDP growth of oil importing economies suffers from increases in oil prices, in both linear and non-linear models. With regard to the two net oil exporters in our sample, Norway benefits from oil price hikes while, in the UK, a rise in oil prices is found to have a significant negative impact on GDP growth. These contrasting results for oil exporting countries can be traced to a sharper real exchange-rate appreciation in the case of the UK. In the case of net oil importer, Japan, the results obtained using the optimal order of the model indicate a positive association between oil prices and real performance.

Rodriguez and Sanchez (2004) used multivariate VAR methodology to analyse the outcomes of high oil prices on economic growth for oil exporting, as well as importing, OEDC countries (individual G-7 countries, the Euro area and Norway). By using both linear and nonlinear (scaled) models, they found that the increase in oil prices affects the GDP growth rate with greater magnitude.

Kiani's (2008) paper discussed the impact of higher oil prices on Pakistan's economy between 1990 and 2008. The Ordinary Least Square (OLS) technique is used. Several results can be were drown from the study. A sharp rise in the price of crude oil (CO) affects the output negatively, regardless of whether the price of CO is less than or more than the critical value. Therefore, although the CO price has a negative impact on real output, and the same relationship between real government expenditures and CO price is examined, it may suggest that only fiscal policy is not effective in increasing GDP growth. Instead, a sound market price is expected to raise government spending and real output because of the wealth effect for the household and the effect of the balance sheet for firms. Results show a degree of positive change to the real GDP and other factors; they also show that a rise of price of crude oil affects the output negatively. The variables are the following: real GDP in millions, real interest rate in percentage, real government spending in percentage, real government revenues in percentage, real stock price in percentage and real crude oil prices $/barrel.

Farhani (2013) uses the estimated simple linear regression model (SLRM), dynamic regression model (DRM) and VAR model to evaluate the impact of oil price increases on economic growth in the United States (U.S.). From the abovementioned model, the study presents non-significant coefficients or a bad adjustment in the direct relationship and it present a weakening effect in the direct relationship. For this reason, the passed to first use a breakpoints detection test and then apply the Vector Error Correlation Model (VECM) by introducing another factor which has a significant relationship with the economic growth and oil price of the United States and which improved the results of the study. Therefore, the study concluded that the impact of oil price increases on economic growth depends on the comprehension of this topic and the choice of the appropriate model. As a consequence of these factors, the results can be different between work papers and they would still deserve further attention in future research.

Eltony (1999) analyses the impact of oil price fluctuation on the economy of Kuwait. In this study, the Vector Auto-regression Model, Vector Error Correction Model and Structure VAR Model were all estimated using seven key macroeconomic variables for the State of Kuwait. Quarterly data was collected for the period 1984 to 1998, for the following variables: oil price of Kuwait blend crude oil revenue, government development expenditure, government current expenditure, consumer price index, money demand and the value of imports of goods and services. The results indicated that shocks to oil prices, and consequently to oil revenues, are found to be very important in explaining most of the forecast errors variance of government expenditure, be it current or development. However, government development expenditure has been more responsive to oil shocks than current expenditure. Furthermore, the results clearly show the importance of both types of government expenditure in explaining the forecast errors variance of the CPI. Alternatively, the value of imports is also explained satisfactorily by oil shocks but more closely follows fluctuations in both kinds of government expenditures, especially those of development expenditure.

Katsuya (2005) examines the impact of oil prices on macroeconomic variables in Russia, using the VAR model. The timespan covered by the series is from 1994Q1 to 2009Q3, providing 63 observations. The analysis leads to the finding that a 1% increase (decrease) in oil prices contributes to the depreciation (appreciation) of the exchange rate by 0.17%, in the long run, whereas it leads to a 0.46% GDP decline. Likewise, we find that in the short run (8 quarters) rising oil prices cause not only growth in the GDP and exchange rate depreciation, but also a marginal increase in the inflation rate, in the long run. Overall, these results lead to the conclusion that the Russian economy is significantly vulnerable to oil price volatility.

2.2.2 Developing countries

Trung and Vinh (2011) use Vector Autoregressive (VAR) modelling and cointegration techniques to evaluate the impact of oil prices, real effective exchange rate and inflation on the economy of Vietnam. Trung and Vinh make use of monthly data from the period 1995 to 2009.The results show evidence of a long run relationship between oil prices, inflation, exchange rate and economic activity. The results suggest that both oil prices and real effective exchange rate have a significant impact on economic activity. An increase or decrease in oil price may enhance economic activity. Their main results suggest that economic activity, oil prices, inflation and an effective exchange rate are cointegrated; that is, they share a long run relationship. Oil price reduction and CPI have a positive and significant effect on economic growth. More precisely, in the long run, a 10 percent permanent increase or decrease in the international oil price is associated with a 1.81 percent increase in economic growth, or decline. Similarly, a permanent 10 percent increase or decrease in the level of CPI is associated with a 3.7 percent increase or decrease in economic growth.

Bouzid (2012) studied the relationship between oil prices and economic growth in Tunisia over the period 1960 to 2009.The study makes use of the Vector Error Correction model (VECM) analysis. Using the long run vector coefficients, He examined the sensitivity of real GDP in Tunisia to shock in international oil prices. The results of the long run analysis, for instance, indicated that a 10 percent permanent increase in crude oil price internationally will cause the real GDP to decrease by 3.36 percent. This shows that Tunisia's GDP decreases more by oil price increase; this is consistent with the expectation. Lastly, the results from the short run Vector Error Correction Model (VECM) showed that the coefficient is correctly signed and statistically significant. This suggests that the long run equilibrium influences short run dynamics. In Tunisia, real GDP has an automatic adjustment mechanism and the economy responds to deviations from equilibrium in a balancing manner.

In their study, Mohammad and Gunther (2008) analyse the dynamic relationship between oil price shocks and major macroeconomic variables in Iran, by applying a VAR approach. The study points out the asymmetric effects of oil price shocks; for instance, positive as well as negative oil price shocks significantly increase inflation. The study also reveals a strong positive relationship between positive oil price changes and industrial output growth. The empirical findings of this study suggest that positive oil price shocks increase the real effective exchange rate and appreciate domestic currency in the mid run, which is one of the syndromes of a Dutch disease. This reduces the price of imports and increases the price of exports. Real imports and domestic output per capita increase significantly and allow one to observe the initial inflationary effects of positive oil shocks. Real government expenditures also only increase in the mid run and are marginally significant. The effects of the oil stabilization fund for mitigating the inflationary effects of a positive shock, and protecting the annual state budgets from external shocks, should be important. The Iranian economy is much more vulnerable to the negative shocks of oil prices; the real effective exchange rate falls significantly (domestic currency depreciates) until the end of the period (12 quarters).

Osman and Mohamed (2000) assess the effect of oil on economic development in Sudan. Their study provides a comprehensive analysis using the most recent secondary data, with a view to clarifying the positive and negative effects of oil on Sudan's economic development. The results find that the country's recent dependence on oil may spark other problems because it is an exhaustible resource and the instability of oil prices in the international market could produce uncertainty in domestic growth. The Sudanese economy will be affected negatively and lose most of the oil reserves (70%) and oil revenues (50%),while Southern Sudan will remain dependent on the main pipeline passing through the north. Even after Southern Sudan's independence, Sudan will remain the former's only export route through a pipeline ending in the seaport in Port Sudan at the Red Sea.

Oluwatosin (2003) investigated the impact of an oil price increase on economic growth in Nigeria. The study determined the impact of oil price shocks on gross domestic product, by using government revenue, monetary indicators, government consumption and inflation as variables. The study employs the multivariate autoregressive model, using quarterly data from 1985 to 2008; the results indicated that oil price shocks do not account for a significant proportion of observed movement in macroeconomic aggregate. This pattern persists despite the introduction of threshold effects; this implied the enclave nature of Nigeria's oil sector with weak linkages. The findings show that the impact of oil price shocks on most of the macroeconomic variables in Nigeria is, at best, minimal. Specifically, the results of the impulse response functions and variance decomposition analysis, to a large extent, confirmed that oil price shocks are only able to explain a small proportion of the forecast error variance of these macroeconomic aggregates. Oil price shocks, as revealed by variance decomposition, accounted for less than 1% of the variations in output, inflation and government revenue.

In their study, Oriakhie and Iyoha (2010) examine the consequences of oil price volatility on the growth of the Nigerian economy during the period 1970 to 2010. Using quarterly data and employing the VAR methodology, the study finds that of the six variables employed, oil price volatility impacted directly on real government expenditure, real exchange rate and real import, while impacting on real GDP, real money supply and inflation through other variables, notably real government expenditure. This implies that an oil price change determines the government expenditure level which, in turn, determines the growth of the Nigerian economy. This result seems to reflect the dominant role of the government in Nigeria. Considering the destabilizing effects of oil price fluctuations on economic activity and government spending in Nigeria, the study makes some recommendations. Results from the Granger-causality tests and VAR show that the interaction between oil price volatility and macroeconomic variables in the Nigerian economy is significant, with the direction of causality going in at least one direction. Oil price volatility is found to impact on real GDP through other variables in the economy; these variables were found to be real government expenditure and real exchange rate.

Salim (2009) empirically investigates the impact of oil price volatility on six major emerging economies of Asia; namely, China, India, Indonesia, Malaysia, Philippines and Thailand. According to Andersen et al. (2004), quarterly oil price volatility is measured by using the realized volatility (RV).For China, according to the VAR analysis along with the Granger causality test, generalized impulse response functions and generalized variance decompositions, it can be inferred that oil price volatility impacts output growth in the short run. For India, oil price volatility impacts both GDP growth and inflation. In the Philippines, oil price volatility impacts inflation. For the Indonesian economy, oil price volatility impacts both GDP growth and inflation before and after the Asian financial crisis. In Malaysia, oil price volatility impacts GDP growth, while there is very little feedback from the opposite side. For Thailand, oil price volatility impacted output growth for the entire period studied.

2.2.3 South Africa

Modise et al. (2013) investigated the impact of the oil supply and demand shocks on the South African economy using a sign restriction-based structural Vector Autoregressive (VAR) model. The results show that an oil supply shock has a short-lived significant impact, only on the inflation rate, which has a negative impact on the South African economy, while its impact on the other variables is statistically insignificant. Supply disruptions result in a short-term increase in the domestic inflation rate, with no reaction from the monetary policy.

Essama-Nssah et al. (2007) explore oil price shock on the South African economy. The study employs the computable general equilibrium model (CGE) and micro simulation analysis of household surveys including the following variables such as GDP, real exchange rate, total absorption, exports and imports. The analysis finds that a 125% increase in the price of crude oil and refined petroleum reduces employment and GDP by approximately 2%, and reduces household consumption by approximately 7%.As a result, the ratio of oil and non-oil commodity prices has so far not risen as sharply as it did for oil importing countries when compared to the previous shock of 1999-2000.

Fofana et al. (2009) studied oil prices and the South African economy by employing the computable general equilibrium model. The model predicts that GDP would fall by between

0.8 and 3 percent under the two scenarios. The government deficit would worsen by between 9.6 and 33.5 percent. The real exchange rate depreciates more in the floatation scenario. Consumption increases by 0.5 percent when prices are subsidised and decreases by 1.1 percent when price fluctuation is allowed. Consequently, unemployment rates increase among low skilled workers; all other industries experience a fall in their production but with different magnitudes. There is a significant increase in the wage gap between urban and rural highly skilled workers when domestic oil prices are subsidised compared to when they are not. Household welfare falls and poverty increases when prices are floating but increase when they are subsidised. The increase of oil prices in the context of subsidized domestic petroleum prices is in favour of rural households, especially richer rural households.

Chitiga et al. (2009) examine the effect on the economy and households of either subsidising or allowing the fluctuation of domestic petroleum prices, in response to exogenous oil price increases in South Africa. An energy focused CGE model is used for analysis. The model predicts that GDP would fall by between 0.8 and 3% under the two scenarios. The government deficit would worsen by between 9.6 and 33.5%. The real exchange rate depreciates more in the floatation scenario. Consumption increases by 0.5% when prices are subsidised and decreases by 1.1% when price fluctuation is allowed.

2.2.4 Assessment of literature

An assessment of empirical literature showed that the relationship between oil prices and economic growth can be either negative or positive. Table 2.1, below, provides a summary of empirical literature and a guide for selecting variables. The summary also provides different countries and the use of different models but the variables used, according to their respective empirical models, are similar. This might depend on a number of factors including whether the country is an oil importer or exporter; as such, the results from previous studies are inconclusive regarding the relationship between the two variables. Several studies used the VAR, VECM and cointegration tests in order to test the relationship between the two variables; however, they came to different conclusions. This shows that this area of study still needs to be investigated. This study draws ideas from previous studies in an attempt to investigate the relationship between oil price volatility and economic growth in South Africa.

Table 2.1, Summary of selected empirical literature of oil price volatility on economic growth.

Authors	Country	Period	Methodology	Variable	Oil price effect on GDP
Rebecca et al. (2004)	Norway, Japan U.K.	-	Multivariate, VAR	GDP,RER, oil prices, real wages, inflation and RIR	Positive effect in Norway and Japan, negative effect UK
Cologni and Manera (2005)	G7 Countries	1985-2005	VAR	GDP, oil price RIR, inflation, unemployment and RIR	Negative effect
Kiani (2004)	Pakistan	1990-2008	OLS	GDP, RIR. government spending, stock price and crude oil price	Strong positive effect
Katsuya (2005)	Russia	1984-1998	VAR and VECM	GDP, oil prices, inflation, RIR, RER	Negative effect in short-run and positive effect in long-run

Trung and Vinh (2001)	Vietnam	1994Q1-2009Q3	VAR	GDP,RER,RIR, inflation, CPI, oil prices	Positive effect in long-run and negative effect in short-run
Essama-Nssah et al. (2007)	SA	1999-2010	VAR	GDP,RER,RIR, exports, imports and oil prices	Negative effect on short-run and positive effect in long-run
Okwatosin (2013)	Nigeria	1985-2008	Multivariate	Oil prices, GDP, Inflation, consumption	Positive effect
Oriakhie and Iyoha (2010)	Nigeria	1970-2010	VAR	Oil price, government expenditure, RER, imports, GDP, money supply, inflation	Positive and significant effect
Salim (2009)	Six major countries	-	VAR	Oil price, GDP, money supply	Significant positive effect
Modise et al. (2013)		-	VAR	GDP, RER, imports, exports, oil prices	Negative effect in short-run and positive effect in long-run

Fofana et al. (2009)		-	CGE	GDP, RER, government, RER, Unemployment, Households consumption and oil prices	Negative effect
Bouzid (2012)	Tunisia	1996-2009	VECM	Oil price, GDP, RER, RIR, Inflation, CPI, oil prices	Positive effect in short-run and negative effect in long run
Mohammed and Gunther(2008)	Iran	-	VAR	Oil prices, inflation, REER, government, RIR, Import and exports	Positive effect

2.3 Conclusion

This chapter reviewed the theoretical literature relevant to the link between oil price volatility and economic growth. The chapter focussed on the theoretical literature followed by discussions of the empirical findings of studies related to the topic of this study. The theoretical literature includes the transmission mechanism which explains the oil price volatility goes through in order to affect the economic growth; Harrod-Domar holds the factors that determine growth in the economy; neoclassical growth theory holds that production is a function of capital and labour, all of which contribute to the growth of the economy, and the endogenous growth theory which also holds that output is a function of capital. Empirical studies on the impact of oil price volatility on economic growth in developed and developing countries, as well as in South Africa, were reviewed herein. The studies employed different models which computed different results, depending on whether the country is oil importing or producing. Most of the studies show that oil price volatility is likely to affect the GDP growth rate negatively in the short-run and positively in long-run, especially in the case of oil importing countries.

CHAPTER THREE

An overview of oil prices and economic growth in South Africa

3.1 Introduction

The purpose of this chapter is to present an overview of and the trends related to the variables used in the econometric model for estimation techniques in this study. The chapter begins byproviding economic growth trends. This is followed by a presentation of trends in crude oil prices, interest rates, exchange rate trends and gross fixed investment during the period 1994Q1-2010Q4. Concluding remarks are provided towards the end of the chapter.

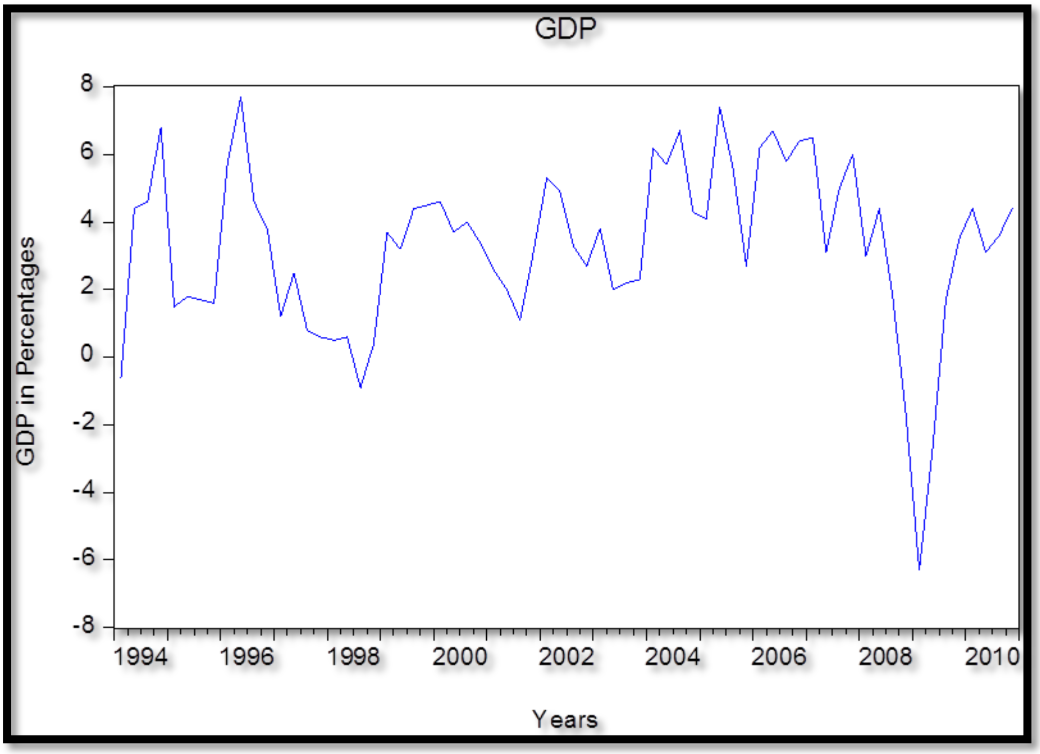
3.2. Overview of economic growth in South Africa

GDP is the total rand amount of all goods and services produced over a specified period. The growth rate is the percentage increase or decrease of the GDP's previous measurement cycle. Gary (2008) states that the growth rate of GDP is, to a large extent, driven by government expenditure, investment, exports, imports and other variables. If imports are greater than exports this would be harmful to the economic performance of the country and lead to a decrease in the GDP rate.

Since 1994, after the first democratic elections in South Africa, there have been some improvements in economic growth in South Africa despite the fact that economic growth has remained stable by averaging almost 3% per annum. This resulted in the South African economy growing at a very slow rate between the periods 1997 and 2010. This positive growth rate, although at low levels, was a consequence of a number of macroeconomic policies that were adopted in South Africa, namely: GEAR, ASGISA, and NGP to mention a few. Where GEAR, ASGISA and NGP aims is to increase economic growth to sustainable rates of between 6% and 7% .These macro-economic policies also played an important role in the sustainable economic growth which also led to an increase in the South African GDP (Mtonga, 2011; Smit and Du Plessis, 2007).

The 3% average growth rate for the first ten years after the end of apartheid was in fact a disappointment, relative to the expectations of many in South Africa. This growth was substantially lower than what was deemed necessary to support a lasting transition to democracy in South Africa (GEAR, 1996). Positive growth rates of GDP have mainly been the result of domestic consumption. Lee (2005) states that a growing economy means that there is a greater demand for commodities; oil is one of these commodities. Because of the great demand for oil, the price of crude oil has significantly increased over the last few years, which has affected the performance of industries and the economy (Sill, 2007). GDP growth trends are portrayed in Fig 3.1 below.

Figure 3.1: GDP trends from 1994Q1 to 2010Q4



Source: SARB (2013)

Figure 3.1 shows the quarterly trends of South African real GDP from 1994 to 2010.The first quarter of the 1994 GDP rate was very low, from -0.6%. Moving to the fourth quarter of 1994 there was a dramatic increase to the economic growth rate of South Africa, which increased brought the GDP up to 6.8% (DTI, 2013). According to SARB (2011), the increased growth rate was due to the attainment of democracy in the year of 1994 which opened doors for South Africa to engage in international trading and created investment confidence in the country.

There was a significant decline in GDP growth from 1995Q1 (1.5%) to 1995Q4 (1.6%). These were the very low growth rate percentages experienced by the South African economy in 1995. From 1996Q2, South Africa again experienced an increase in the GDP growth rate. Smit and Du Plessis (2007) state that an improvement in economic performance leading to the achievement of a 7.7% GDP growth rate was primarily the result of large foreign capital inflow in the existence of a low inflation rate and interest rate. This strong growth rate was the recovery from the year 1995, where a low GDP rate that ranged between 1.5% and 1.6% was experienced.

However, from 1996Q3 South African economic growth started to take a downward trend until it reached -0.9 in 1998Q3. From this period, South African economic growth never really reached a very low GDP rate; it has always fluctuated around 4.3% up to 6.4%, except in 2001 where the GDP rate was 1.1%. The fluctuations were maintained by the fiscal and monetary policy which was adopted by the SARB in 2000. These policies helped South African economic growth by stabilizing the economy and increasing investment.

Since 2008, there was a huge decrease in South African economic growth which led to a large drop out of GDP of -6.3% in 2009Q1. This was due to an increase in international oil prices in 2008 which caused a high inflationary rate in 2009; this increased the price of commodities. According to Kahn (2008), the South African total output decreased by more than 1.6% due to the high cost of production. This sluggish growth rate was mainly a result of the global economic downturn.

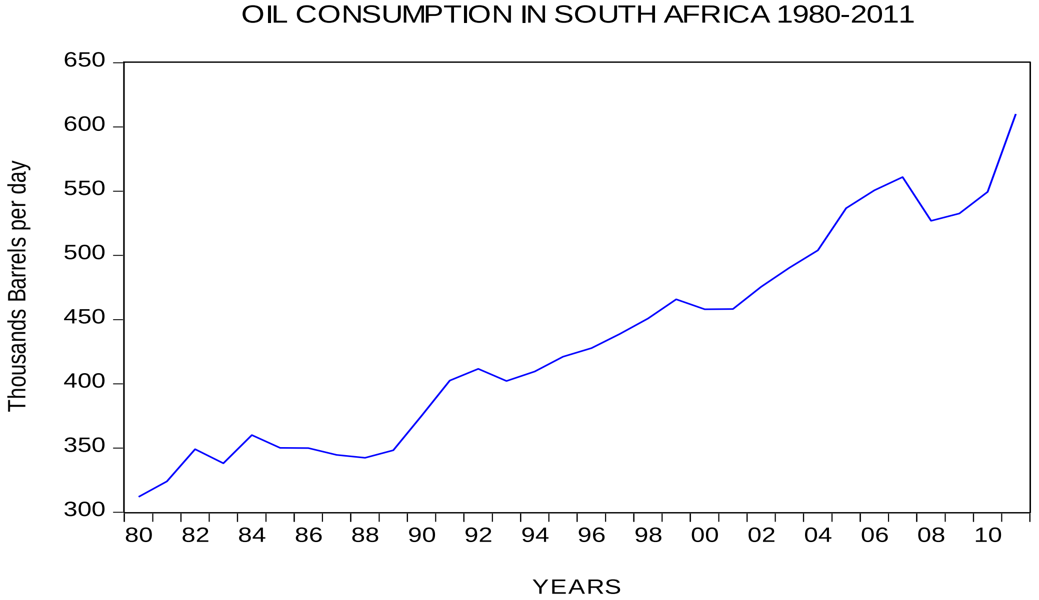
3.3 Overview of crude oil price in South Africa

South Africa is an oil importing country which makes its economic growth more vulnerable to oil price shocks. South Africa is highly dependent on oil imports and high energy intensity per unit of GDP. Fourteen percent of South Africa's primary energy needs are met by oil; some 95% of crude oil is imported, mostly from Saud Arabia and Iran. However, imported crude oil constitutes about 65% of the South African consumption of petroleum products (Wabiri and Amusa 2010).

The majority of South African crude oil imports are from OPEC countries, namely Iran (27%), Saudi Arabia (27%), Nigeria (20%) and Angola (11%) (GTA, SARS, 2011). According to SA information (2013), South Africa requires roughly 570 000 barrels of oil every day which makes the South African economy vulnerable to oil price shocks since it is an oil importing country. Oil consumption trends are portrayed in Figure 3.2 below.

3.3.1 Oil consumption in South Africa from 1980 to 2011

Figure 3.2: Oil consumption in thousands of barrels per day in South Africa.

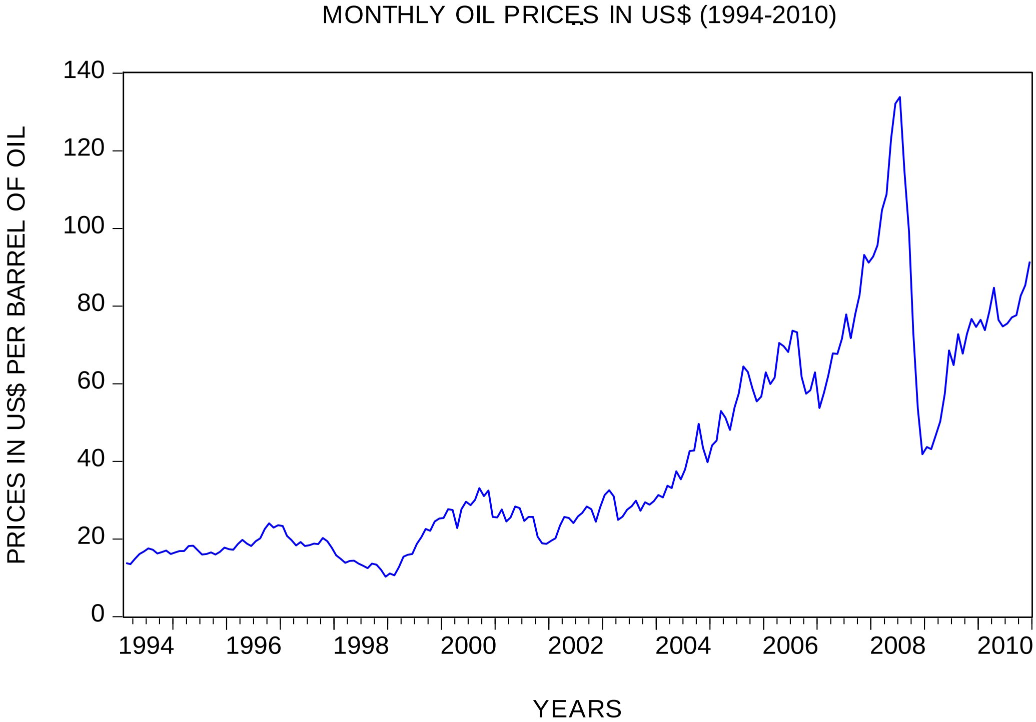


Source: Adapted from US Energy Information Administration (2013).

Figure 3.2 shows an increasing trend in oil consumption per day since 1980. In 1980, oil consumption was approximately 312 000 barrels of oil per day. This figure was standing at 375000 barrels per day by 1990. This shows an average increase of approximately 345 000 barrels per day over a ten year period, indicating an average of 1.94 percentage change, per day, over the same period. Between 1990 and 2000, oil consumption increased by an average of 424 000 barrels per day, amounting to approximately 2.56 percentage change per day over the same period. Between 2001 and 2011, oil consumption increased by an average of 527 000 barrels per day meaning an average percentage change of approximately 2.72 per day. On the whole, these figures suggest that over a period of 32 years oil consumption in South Africa was 434 000 barrels per day; this suggests an average percentage change of 2.25 per day over the same period.

Clearly South Africa is an oil dependent economy which makes it more vulnerable to oil price shocks. It is thus not necessary to mention the negative impact that this might cause in the current account of the balance of payments, since oil is an imported commodity. It is against this background that this dissertation hypothesises that oil price volatility is likely to dampen economic growth in South Africa. Oil prices are denominated in US dollars; this means that oil prices in South Africa are affected by the exchange rate. The next section presents quarterly data on oil prices over a period of 1994 to 2010.

Figure 3.3: Oil prices from 1994 to 2010monthly figures



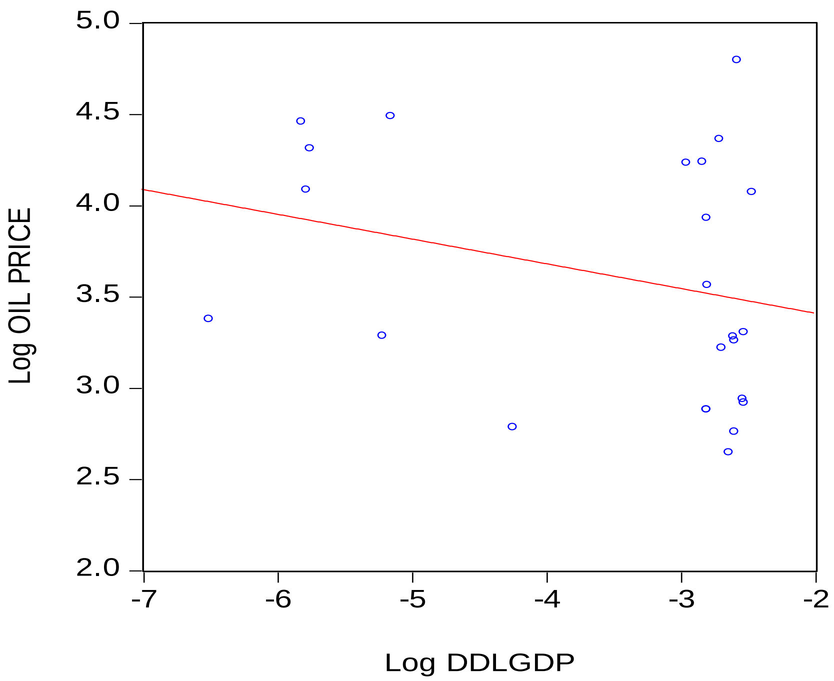
Source: DTI, 2013

Figure 3.3 shows the trends in oil prices during the period 1994 to 2010. The prices shown are monthly prices of a barrel of Brent crude oil measured in U.S. dollars. Analysing the period from 1994 to 1999, oil prices have been fluctuating just above US$40 per barrel of crude oil. During January to December 2000, there were relatively stable oil prices which varied between US$25 and just a little lower than US$30 per barrel. The reason for this fluctuation was because of OPEC's spare production capacity which helped to stabilise oil prices (Hamilton, 2003 and Brown, 2006). The oil price decrease in 2001, to US$18.8, was a result of slow global economic growth leading to low oil demand. However, from 2002 up to 2007 oil prices were on an upward trajectory which culminated in oil prices reaching a peak of approximately US$120 by 2007. In October 2008, oil prices collapsed due to the effects of financial crises. The price of oil fell by about two thirds from its peak of US$147 per barrel to US$41.4 by the end of December 2008 (DTI, 2013).

Oil price changes have a significant bearing on economic growth in South Africa. Similarly, economic performance does have some influence on oil prices in that, during the time of high levels of economic activity, the demand for oil is likely to increase leading to an increase in oil prices, *ceteris paribus*. Alternatively continuously increasing oil prices may dampen economic growth as a result of inflationary pressures. The relationship between oil prices and economic growth is portrayed in Figure 3.4 below.

3.3.2 Oil price and GDP from 1994Q1 to 2010Q4

Figure 3.4: Oil prices and GDP 1994Q1-2010Q4



Sources: SARB, 2013

Figure 3.4, above, portrays the relationship between oil prices and GDP. Oil prices and GDP have an inverse relationship. The rising oil prices and price volatility serve to suppress economic activity and reduce asset values. Hwang and Huang (2002) state that higher oil prices yield subsequent recessions in oil consuming nations, as oil prices are negatively correlated to economic activities. Considering the period of 2008 where the oil price jumped to $144, oil importers like South Africa experienced negativity in their economic activities, regardless of their trade balance. Such oil price volatility reduces the planning of horizons, causing firms to postpone investments. South Africa experienced difficulties in terms of formulating a robust budget as it experienced a high degree of uncertainty of import costs and fuel subsidies.

Hamilton (2009) stated that the correlation between oil price evolution and economic output was not of a historical coincidence for the 2008 to 2009 period. An increasing oil price was followed, 3-4 quarters later, by slower output growth with a recovery beginning at the end of 2009. In effect, asymmetry means that oil price increases have a clear negative impact on economic growth while oil price declines do not affect economic activity significantly.

Ferderer (1996) showed that both oil price changes and oil price volatility have a negative impact on economic growth, but in different ways. Oil volatility has a negative and substantial impact on economic growth, immediately and again eleven months later, whereas oil price changes have an impact on economic growth after about one year. In addition, oil price volatility is strongly correlated with oil price increase so oil price increases are considered more important for oil price volatility variance than the negative price changes, in terms of explaining the effect on the GDP growth rate in the country. Therefore, there is no doubt that the negative impact of oil price increase and oil volatility affects South African economic growth during the year 1994-2010. The sharp increase in the price of oil in the last half of 2007 and first half of 2008 has led many to argue that increased speculation in commodity markets has played a role in this trend; indeed, there is evidence of increased activity in these markets. The graph suggests that the GDP loss was incurred due to the increase in oil price volatility during the period under review.

3.4. Overview of interest rate

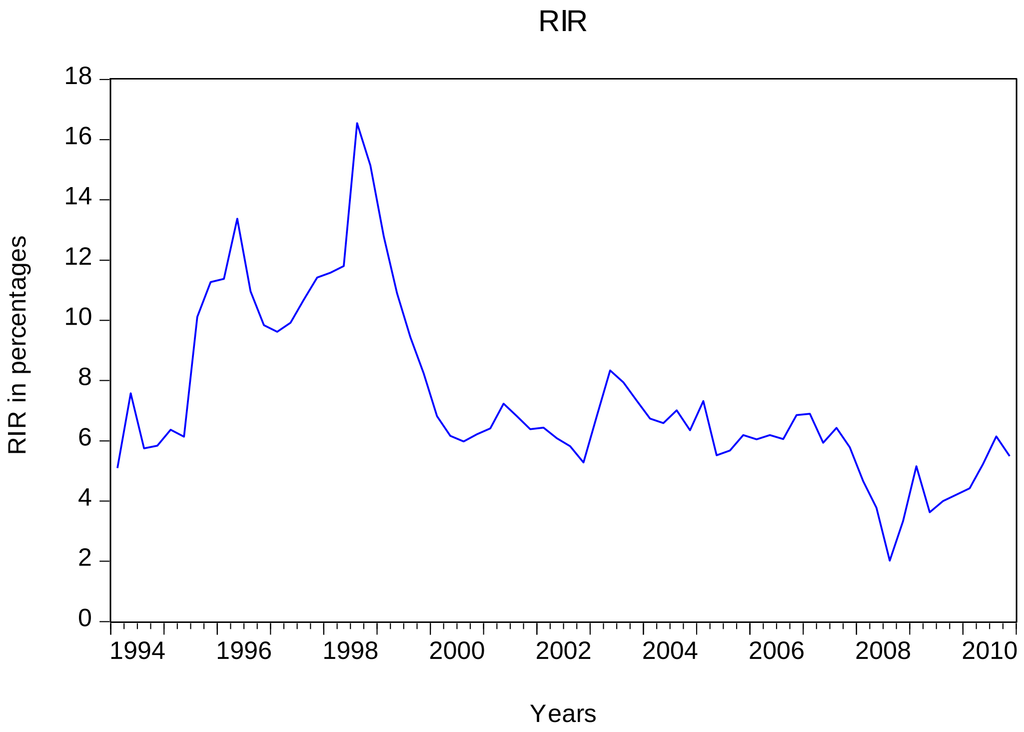
According to Davidson (2007), real interest rates lie at the heart of the transmission mechanism of monetary policy. Although, in the long run, real interest rates are determined by real factors such as the propensity to save and the productivity of capital, the South African Reserve Bank uses interest rates in its inflation targeting framework. The interaction between real interest rates and economic growth became very important. In South Africa, attention was focused on real interest rates particularly in the aftermath of the 1997/98 Asian crisis, when short-term real interest rates became highly positive.

The classical view of the real interest rate is that interest rates reflect a level of capital productivity which determines the demand for capital, and the forces behind saving behaviour(Kahn and Farrell, 2007).The Keynesian view is that the interest rate is determined in stock markets as portfolio holders choose between safe and risky assets and make temporal choices. The traditional view is that the real interest rate is only determined by the fundamentals of productivity and economy (Kahn and Farrell, 2007).

Real interest rate targets are a vital tool of monetary policy and are taken into account when dealing with variables like investment, inflation and unemployment. The central banks of countries generally tend to reduce interest rates when they wish to increase the investments and consumption in the country's economy. The implementation of a low interest rate as macro-economic policy can be risky (Du Plessis et al., 2008).

According to Fisher (1997),the real interest rate is the nominal rate minus the inflation rate. Inflation and interest rates are linked, and frequently referenced in macroeconomics. Inflation refers to the rate at which the prices for goods and services rise. It is argued that the real interest differential potentially reflects several factors, namely: aggregate demand, inflation, productivity, and persistent monetary policy (MacDonald, 1997). Figure 2.4.1 below offers an overview of real interest in South Africa from 1994Q1 to 2010Q4.

Figure 3.5 Trends of real interest rate from 1994Q1-2010Q4



Source: DTI (2013)

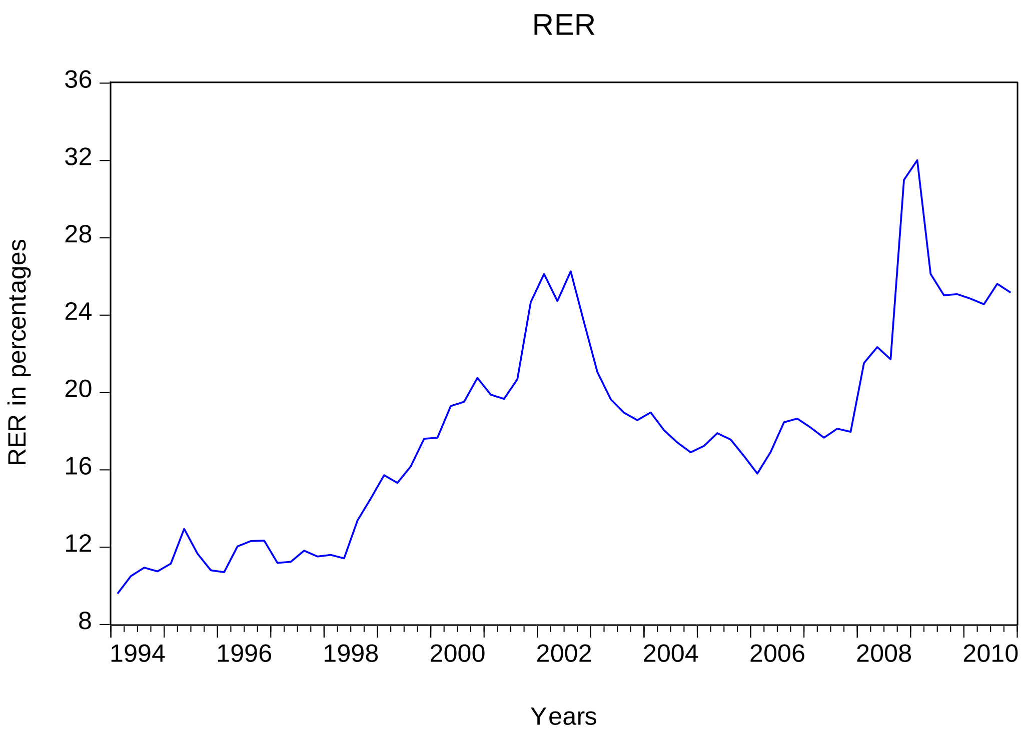
Figure 3.5 shows the trend of real interest rate during the period 1994Q1 to 2010Q4.The graph shows that there was a decrease in the rate of interest of 7.58% in 1994Q2 to 5.75% in 1995Q2.The decrease in the interest rate discouraged savings and encouraged borrowing, which negatively affected economic growth. From 1995Q3 to 199Q2 there was a slight increase in the interest rate from 10.11% to 13.37%; it then started to decrease in 1996Q4 to 9.84%. From 1997Q4 to 1998Q3 the real interest rate increased from 11.42% to 15.14%.

Consumers and businesses respond to a fall in the interest rate by consuming more, especially in regards to the consumption of durables. Alternatively, they increase their investment if their outlook is poor. Thus, increasing expected inflation is one means of lowering real interest rates. From 1999Q2 to 2000Q3, there was a decrease on the rate of interest from 10.9% to 6.16%. In 200Q3, the real interest rate was relatively low by 5.98% and continued to decrease to 5.28% in 2002Q4. However, in 2003Q2 it rose to 8.34%. and decreased again to 6.5% in 2006Q3.The real interest rate was relatively stable from 2006 to 2007Q3, at 6.43%. In 2008Q3 real interest dropped to 2.02% and in 2009Q1 the rate of interest was raised to 5.16%and continued to rise in 2010Q2 to 5.23%.

3.5. Overview of exchange rate

Real exchange rates significantly affect production, employment and trade, so it is crucial to understand the factors responsible for their variations. Throughout history, various international monetary systems and different types of foreign exchange rates regimes existed. These various types of exchange rates served to manage not only countries' domestic economic affairs but also international trade relations. Real exchange rates have become more visible in the increasingly global economic environment and are very useful for both promoting trade and maintaining monetary stability. Figure 3.6 below shows the trend of exchange rate from 1994Q1 to 2010Q4.

Figure 3.6: Trend of real exchange rate in South Africa from 1994Q1-2010Q4



Source: SARB, (2013)

Figure 3.6 shows the real exchange rate from 1994Q1 to 2010Q4.From the period 1994 to 1995, the rand was fairly strong due to the new democratic government. After the democratic elections in 1994, the economy experienced a relative large inflow of investments thus leading to a stable and relatively strong rand between 1994Q1-1998Q3. This has resulted in an increase in capital inflows; this implies that an increase in capital inflows results in an appreciation of the rand.

In 1998 the real exchange rate has appreciated from 11.59% to 19.51% in 2002Q1and continues to go higher in 2003 to 24.71%. This has caused the rand in South Africa to depreciate which has increased the exports. According to Savvides (2010), this depreciation is mainly attributed to the attacks on America in 2001 and a volatile political situation in Zimbabwe, which led to substantial capital withdrawals from South Africa. According to Calvo and Reinhart (2000), the exchange rate has an impact on real economy and is more vulnerable to terms of trade swings as well as sudden stops of capital inflows. The large exchange rates have a significant effect on the financial stability of a country. According to McCauley (2003), states that experience exchange rate changes can create confusion about the objectives of monetary policy and the commitment to the inflation target, particularly when a conflict between objectives arises. An inflation-targeting framework requires exchange rate flexibility.

The appreciation of the South African rand from 19.67% in 2001Q1, 19.89% in 2001Q2 and 24.67%in the final quarter of 2001 provided the first real challenge to the South African targeting regime. Monetary policy was adjusted in 2002 as the forecasts showed a strong pass-through from the exchange rate to inflation. The repurchase (repo) rate was increased by 100 basis points on four occasions during 2002 (Regnier, 2007).

The rand appreciated from 18.65% to 22.33% from 2006Q3 to 2008Q2. The appreciation of the rand goes much further in 2008Q4 to 30.98%. According to Savvides (2010), the reason for the appreciation was caused by the oil shocks and world price crisis. In 2009Q3 to 2010Q1 the real exchange rate of the rand started to depreciate from 25.02% to 24.85% but in 2010 there was an appreciation of 25.62%

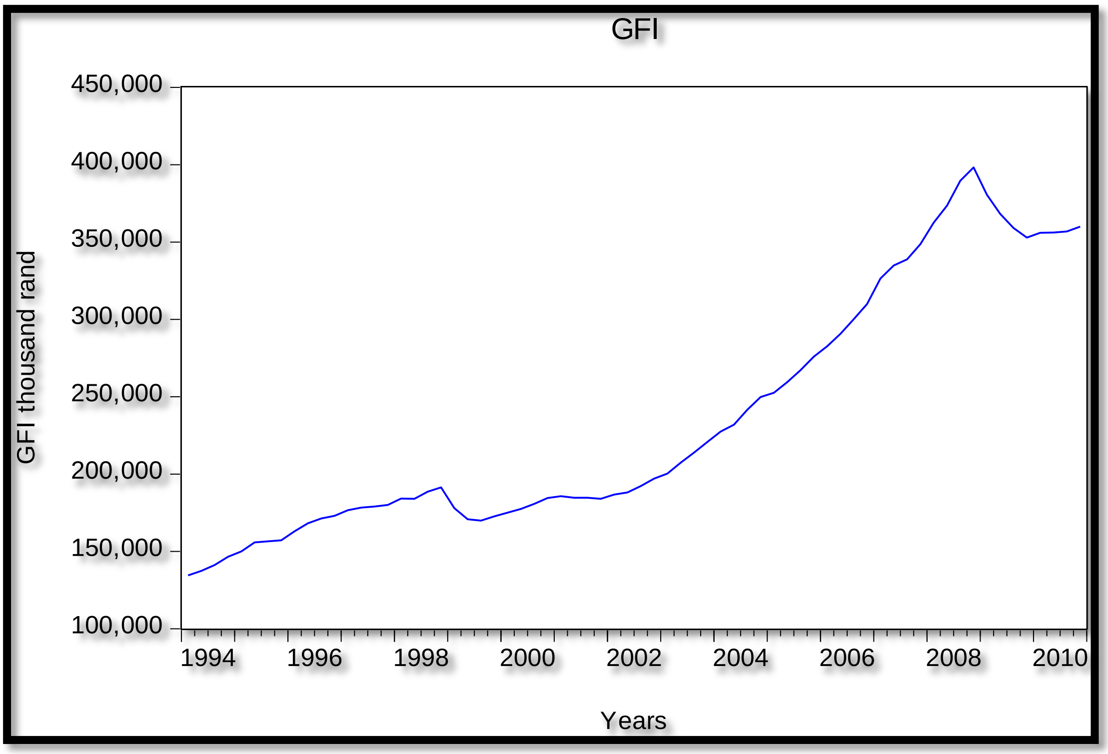
3.6 Overview of gross domestic fixed investment

Gross fixed investment is at the foundation of virtually all value-creating activities in an economy. Gross fixed investment contributes to real economic growth. Gross fixed investment is essentially net investment. Gross fixed investment, however, includes investment in new capital as well the replacement of old, worn and broken machinery, infrastructure and equipment. New fixed investment enhances the productive capacity of an economy.

Gross fixed investment plays a key role in the process of economic development, by enhancing aggregate demand in the economy and improving the production capacity of the economy. Infrastructure bottlenecks are currently recognised as binding constraints which inhibit South Africa’s economic progress, and their removal through appropriate capital projects has been targeted by government as a key priority.

Prior to the devastation caused by the 2008/2009 recession, the private sector was the biggest driver of domestic investment. However, the lack of investment by the public sector (improved rail, road and overall infrastructure) was not supportive of maximum business expansion, which is critical in job creation (Unezea, 2013). Following the energy crisis, government through its public corporations increased capital outlays. Increased investment expenditure, in particular Eskom and Transnet, supported investment growth. Figure 3.7, below, shows the graph of gross fixed investment.

Figure 3.7: Trends of Gross fixed investments from 1994Q1 to 2010Q4



Source: SARB (2013)

Figure 3.7 shows the trend of gross fixed investment of South Africa. Before South Africa entered into a new political dispensation the average growth of GDP was below the real fixed capital. From 1994Q1, the gross fixed investment has been increasing at a rate of R13737 in 1994Q1 to R155742 in 1995Q2.The investment goes further in 1996Q4 by R172870 to R191359 in 1998Q4.This highlights the strength of business confidence and investment. In 1999Q2 there was a decrease in investment to R170761 but 2001Q1 started to increase slowly to R185603 and goes further in 2003Q2 to R207299. The decline in 1999 was caused by the decrease in general government investment spending, which declined by 12.5% (Van de Merwe, 2004).

The steady increase in real gross fixed capital formation from 2002 was abruptly halted as the worsening global financial crisis in 2008 visibly filtered through to aggregate capital investment from the first quarter of 2009. Real fixed capital formation contracted throughout 2009, reducing the ratio of capital expenditure to gross domestic product from 24, 6 per cent in the final quarter of 2008 to levels below 20 per cent from the second quarter of 2010 to date. The stagnant and fairly subdued ratio reflected the continued existence of surplus capacity in most sectors of the economy; capital formation is often only ignited when actual output approaches full capacity, so that capital expenditure tends to be a lagging economic indicator.

3.8 Conclusion

This chapter offers an overview of oil price volatility and economic growth in South Africa over the period of 1994Q1 to 2010Q4. Firstly, the chapter provided an overview of South African economic growth from 1994Q1 to 2010Q4 followed by the trend in gross domestic product (GDP) in South Africa. The second part provided an overview of the crude oil price in U.S dollars, then the consumption of crude oil price in South Africa from 1980 to 2010. The was followed by a description of oil price volatility from 1994 to 2010 monthly and the trend established between oil price and GDP. The third part is an overview of the real interest rate in South Africa. The fourth part of the chapter constituted a discussion of the real exchange rate in South Africa, while the last part provided an overview of gross fixed investment in South Africa.

CHAPTER FOUR

Methodology, model specifications and estimation of techniques

4.1 Introduction

This chapter outlines the methodology applied to examine the impact of oil price volatility on economic growth in South Africa from 1994Q1 to 2010Q4.This chapter includes three parts; the first part presents the model specification, definition of variable, data sources and expected priorities. The following part presents the research techniques and diagnostic tests employed in this study. The last part offers concluding remarks.

4.2 Model specifications

In examining the impact of oil price volatility on economic growth in South Africa the choice of variables was informed by the literature reviewed in the previous chapter. This study will modify the Kiani (2000) model. Kiani (2000) examined the relationship between oil price shock and economic growth using the following model:

y = y(z1, z2, z3, z4, z5, z6)…………………………………………………….4.1

y = Real GDP in millions,

z1 = the real interest rate in percentage,

z2 = CPI in percentage

z3 = the real government spending in percentage,

z4 = the real government revenues in percentage,

z5 = the real stock price in percentage,

z6 = the real crude oil prices $/barrel

This study will modify the above model by excluding CPI, government revenue, stock price and adding exchange rate and gross fixed investment to the model. The study will employ Vector Error Correction Modelling (VECM). The gross domestic product (GDP) is a dependent variable. The explanatory variables in this study are oil price (OIL), real interest rate (RIR), real exchange rate (RER) and gross fixed investment (GFI). Using the regression model, the model will take this form:

$GDP_t = B_0 + B_1 \sum_{d=1}^{n_t}(\Delta oil_d)^2\, t + B_2 RIRt + B_3 RERt + B_4\ GFIt + \mu t$……………..4.2

Where, $\beta 0$, $\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$ are coefficients of the explanatory variables, t represents time series and μ is the error term. The error term represents the influence of the omitted variables.

4.3 Definition of variable

These sections provide a discussion of variables and their justification effect on the impact of oil price volatility on economic growth.

GDP = Gross domestic product growth rates in South Africa. The growth rate is the percentage increase or decrease of GDP from the previous measurement cycle (Mohr and Fourie, 2008).

$\boldsymbol{\sum_{d=1}^{n_t}(\Delta oil_d)^2}$= An oil price volatility measure which is constructed by using squared quarterly oil price changes over the period 1994-2010. Oil price variance is the sum of squared daily price changes in a quarter (Hamilton, 2003, Anderson et al., 2003).

Real Exchange rate (RER) = the nominal exchange rate that takes the inflation differentials among the countries into account (Appleyard and Field, 2005).

Real interest rate (RIR) = the nominal interest rate adjusted for expected inflation; it is usually measured as the difference between the nominal interest rate and the expected or actual inflation is shown the nominal prime lending rate and it is expressed in percentages (Mishkin, 2010).

Gross fixed investment (GFI) = the government investment in infrastructure; it is measured in billions of rands (Mohr and Fourie, 2005).

4.4 Data sources

This study uses quarterly data covering the period 1994-2010 in all its variables. The information will be sourced from the Quantec (easydata), SARB and DTI.

4.5 Expected signs of the coefficient

Table 4.1 shows the expected signs of the coefficient

Variable	**Expected sign**	**Explanations**
$\sum_{d=1}^{n_t}(\Delta oil_d)^2$	+/-	*An oil price change may either decrease or increase economic activity. In particular, a sharp oil price increase affects macro-economy adversely for at least two reasons, namely it raises uncertainty about future oil prices and thus causes delays in business investment (e.g. Bernanke, 1983 and Pindyck, 1991). It also induces resource reallocation, for example, from more adversely influenced sectors to less adversely influenced sectors, and such reallocation is costly (e.g. Lilien, 1982 and Hamilton, 1988). The effect of an oil price decrease stimulates economic growth as the cost of production decreases and therefore encourages business investment (Hamilton, 1983).*
RIR	-	*An increase in real interest rates is expected to lead to a decrease in economic growth due to an inverse relationship between investments and interest rates (Mohr and Fourie, 2005).*
RER	+	*An increase in exchange rate (depreciation of the currency) leads to increased exports and therefore increased foreign reserves. This, in turn, leads to increased economic growth (Appleyard & Field, 2005).*
GFI	+	*An increase in gross fixed investment stimulates economic activity and therefore increases economic growth in the country (Mohr & Fourie, 2005)*

4.6 Research techniques

The study employs the Johansen (1995) cointegration technique. The Johansen test which is used to examine if the long run cointegration between variables will apply a Vector Error Correlation model (VECM) and if, there is no cointegration, the Vector Auto Regression (VAR) model will be applied. Firstly, data has to be integrated of the same order. To achieve this, unit root tests to examine stationary data sets are carried out.

4.6.1 Stationarity

Stationarity is defined as the quality of a process in which the statistical parameters (mean and standard deviation) of the process are constant overtime. The value of the covariance between the two time periods depends only on the distance, gap or lag between the time periods and not the actual time at which the covariance is computed (Gujarati, 2004).The most important property of a stationarity process is that the auto-correlation function (ACF) depends on lag alone and does not change the time which the function was calculated. The classical regression assumption is that both dependent and independent variables must be stationary and the errors must have zero mean and finite variance (Brooks, 2008).

A non-stationary time series will have a time varying mean or a time varying variance, or both. If a series is non-stationary it must be differenced *d* times before it becomes stationary then it is said to be integrated of order *d.* This would be written as I (d). An I (0) series is a stationary series, while I (1) series contains one unit root. An I (2) series contains two unit roots, so it would require differencing twice to induce stationarity.

The reasons for data to be tested for stationarity are as follows: first, series can strongly influence its behaviour and properties; secondly, it can lead to spurious regression problems, which means that if two variables are trending overtime, a regression of one on the other could have a high R squared even if the two variables are totally unrelated; thirdly, the standard assumption for asymptotic analysis will not be valid. Thus, the usual t-ratio will not follow a t-distribution, and F-statistic will not follow F-distribution, so it will be impossible to validly undertake a hypothesis test about the regression parameter (Brook, 2008).

4.6.2 Augmented Dickey-Fuller (ADF) Test

A basic test for the order of integration is the Dickey-Fuller test (Gujarati, 2004). The stationarity of a time series can be tested directly with a unit root test. The Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) are the most frequently used unit root tests. The aim of ADF theory was to test the hypothesis that $\emptyset = 1$ in

Y_t=$\emptyset_{yt-1}$+u_t……………………………………………………………………..4.3

Thus, the hypothesis is formulated:

H_0 : Series contains unit root

H_1: Series is stationary

The rejection of the null hypothesis under these tests means that the series does not have a unit root problem. The standard ADF test estimates

Y_t =β_1+$\beta_2\emptyset Y_{\varepsilon t-1}$+$u_t$……………………………………………………………..4.4

Where u_t is the relevant time series, Δ is a first difference operator, t is a linear trend and is the error term. The error term should satisfy the assumptions of normality, constant error variance and independent error terms. According to Gujarati (2004), if the error terms are not independent in equation 4.4, results based on the Dickey-Fuller tests will be biased.

The Dickey Fuller test is valid only if μ_t is assumed not be auto correlated, but would be so if there was autocorrelation in the dependent variable of the regression (Δy_t). The test would thus be 'oversized', meaning that the true size of the test would be higher than the nominal size used. The solution to this shortfall is to use the ADF. The alternative model in the ADF case can be written as:

$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_1 \, \Delta yt - 1 + u_t$…………….......................4.5

Where is a pure white noise error term and where Δy_{t-1}= (y_{t-1} -y_{t-2}),y_{t-2} = (y_{t-2} −y_{t-3}), etc. According to Gujarati (2004), the number of lagged difference terms to include is often determined empirically, the idea being to include enough terms so that the error term in 4.5 is serially uncorrelated. In ADF, as in DF, the test is whether δ = 0 and the ADF test follows the same asymptotic distribution as the DF statistic, so the same critical values can be used.

The calculated value of ADF is then compared with the critical value. If the calculated value is greater than the critical value, we reject the null hypothesis that the series has unit root, thus confirming that the series is stationary. Gujarati (2004) states that an important assumption of the DF test is that the error terms (u_t) are independently and identically distributed. The ADF test adjusts the DF test to take care of possible serial correlation in the error terms (u_t) by adding the lagged difference terms of the regressand.

The Dickey-Fuller test, as is the case with other unit root tests, has its own weaknesses. Gujarati (2002) states that most tests of the Dickey–Fuller type have low power, that is, they tend to accept the null hypothesis of unit root more frequently than is warranted. Therefore, these may find a unit root even when none exists. Power depends on the time span of the data more than mere size of the sample. In addition, the Dickey-Fuller test is weak in its ability to detect a false null hypothesis.

The weakness of the DF test is that it does not take account of possible autocorrelation in the error process or term (u_t). Clemente et al. (1998) noted that a well-known weakness of the Dickey–Fuller style unit root test with I(1) as a null hypothesis is its potential confusion of structural breaks in the series as evidence of non-stationarity.

Blungmart (2000) stated that the weakness of the Dickey-Fuller test is that it does not take account of possible autocorrelation in error process (u_t). If u_t is auto-correlated, then the OLS estimates of coefficients will not be efficient and t-ratios will be biased. In view of the abovementioned weaknesses, the Augmented Dickey-Fuller test was postulated and is preferred to the Dickey-Fuller test.

4.6.2 Philips-Peron (PP) test

Philips and Peron have developed a more comprehensive theory of unit root non-stationarity. The tests are similar to ADF tests, but they incorporate an automatic correction to the DF procedure to allow for auto-correlated residuals. According to Gujarati (2004), the Philips-Peron (PP) test uses non-parametric statistics method to take care of serial correlation in error terms without adding lagged difference terms. The tests often give the same conclusions as, and suffer from most of the same important limitations as, the ADF tests (Brooks, 2008).

4.6.3.1 Criticism of Augmented Dickey–Fuller (ADF) and Philips-Peron (PP) tests

Brooks (2008) argues that the most important criticism of the unit root tests is that their power is low if the process is stationary, but with a root close to the non-stationary boundary. Consider, for instance, an AR (1), data generating process with coefficient 0.95: if the true data generating process is y_t= 0.95 y_{t-1}-1+u_t the null hypothesis of a unit root should be rejected. It has thus been argued that the tests are poor at deciding, for example, especially with small sample sizes.

Brooks (2008) further argues that the source of this problem is that, under the classical hypothesis-testing framework, the null hypothesis is never accepted; it is simply stated that it is either rejected or not rejected. This means that a failure to reject the null hypothesis could occur either because the null was correct, or because there is insufficient information in the sample to enable rejection.

4.6.4 Cointegration test and Vector Error Correlation Model (VECM)

According Brooks(2008), if two variables that are integrated of order one I(1) are linearly combined, then the combination will also be integrated in order I(1). More generally, if variables with differing orders of integration are combined, the combination will have an order of integration equal to the largest. The purpose of the cointegration test is to check whether the variables are cointegrated or not (Gujarati, 2004).It is appropriate to estimate an error correlation model if the relevant variables are cointegrated.

If the series appears to move together over time, it suggests that there exists an equilibrium relationship. This, therefore, shows that even though the variables are non-stationary in the short run, if they are co-integrated, they will move closely together over time and their difference will be stationary.

The Vector Autoregressive (VAR) model is a general framework used to describe the dynamic interrelationship among stationary variables. Brook (2008) states that if the time series is not stationary then the VAR framework needs to be modified to allow consistent estimation of the relationships among the series. The Vector Error Correction (VEC) model is just a special case of the VAR for variables that are stationary in their differences (for instance, I (1)). The VEC can also take into account any cointegration relationships among the variables.

In order to justify the use of Vector Error Correction Model (VECM) there is need to test for cointegration. A VECM is intended to be used with non-stationary series that are known to be cointegrated. Brooks (2008) contends that the VECM has cointegration relations built into the specification so that it restricts the long run behaviour of the endogenous variables to converge in their co-integrating relationships while allowing for short run adjustment dynamics. Brooks (2008) also states that the cointegration term is known as the correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments estimated. Thus, the presence of a cointegration relation forms the basis of the Vector Error Correction Model (VECM) specification.

There are several ways of testing for cointegration such as the Engle-Granger approach which is residually based and the Johansen and Julius (1990) technique which is based on the maximum likelihood estimation on a VAR system.

According to Brooks (2008), Engle–Granger (1987) proposed a four step procedure to determine if two I(1) variables are cointegrated of order I(1) and the steps are as follows: the first is the analysis to pre-test each variable so as to determine its order of integration; the second is to estimate the long-run equilibrium relationship and; third, the estimation of the error correlation model. If the equilibrium regression can be used to estimate the error-correction model then the fourth step is to assess model adequacy.

The Engle-Granger approach suffers from a number of problems, such as: simultaneous equation bias, impossibility of performing hypothesis about the actual cointegration relationship and lack of power in unit root test (Brooks, 2008).

In light of the abovementioned shortfalls of the Engle-Granger approach, this study applies the vector error correction model (VECM) offered by Johansen (1991). The rationale behind the decision is that this approach applies maximum likelihood estimation to a vector error correction (VEC) model in order to simultaneously determine the long run and short run determinants of the dependant variable in a model. This approach also provides the speed of adjustment coefficient, which measures the speed at which the Gross Domestic Product reverts to its equilibrium following a short term shock to the system (Gujarati, 2004).

4.6.6 Johnson technique Based on VAR

The Johansen and Julius (1990) is a technique based on the maximum likelihood estimation on a VAR system. This method is to test for a long run equilibrium relationship and the advantage of this is that it permits the identification of all cointegration vectors within the given set of variables. According to Gujarati (2004), the following steps are used when implementing the Johansen procedure:

i. test order integration
ii. specifying the VAR (k) order
iii. test for cointegration
iv. normalisation
v. Test of hypothesis

Testing for the order of integration of the variables under examination requires that all the variables should be integrated of the same order before proceeding with the cointegration test.

The procedure is specified as follows with a Vector auto-regressive (VAR) model representation of order k:

y_t=$\prod 1\, Y_{t-1}$+$\prod 2\, Y_{t-2}$+$\prod k\, Y_{t-k}$+u_t……………………………………….4.6

Where y_t is a -vector of non-stationary I(1) variables, $k_t$is a d-vector of deterministic variables, and is a vector of innovations. In order to use the Johansen test, the VAR (4.1) above needs to be turned into a VECM specification (Brooks, 2008). We may rewrite this VAR.

The VAR model of equation 4.1 above is turned into a VECM of the following form:

Δy_t=$\mu + \pi_k Y_{t-k}$+$\sum_{i=0}^{q} \Gamma_i \Delta Y_{t=i}$+$\mu_t$……………………………………….4.7

Where q=k-1, ΔYt are all I(0), Γ are n x n coefficient matrices which represent the short run coefficients. π is the matrix whose rank r determines the number of cointegration vectors among the variables. The Johansen test is based on the examination of the π matrices. If r=0 then there are no cointegration vectors. According to Gujarati (2004), if for instance π has reduced rank (r$\leq (n-1)$), this implies that it can be decomposed as follows:

Π=αβ……………………………………………………………………4.8

Where α is an n x r matrices of error correction or speed of adjustment parameters and β represents the long run coefficients. Estimates of β are found by solving the eigenvalue problem so that the eigenvectors corresponding to the r largest eigenvalues form the estimated β matrix. The size of the eigenvalues provides a measure of how large the correlation between the cointegration relationship and the stationary part of the model is. The next step is to establish how many cointegration vectors exist for each of the relationships. Two test statistics are employed, the λ max statistic and the λ trace statistic. The λ max statistic is of the form:

$\lambda_{max}(r,+1)$= -TIn(λ_{r+1})………………………………………………………...4.9

and

$\lambda_{trace}(r)$ = -T$\sum_{i=r+1}^{g}$(In(1-λ_i)……………………………………………….4.10

Where r is the number of cointegration vectors under the null hypothesis and $\lambda_i$is the estimated value for the i^{th} ordered eigenvalue from the matrix. Intuitively, the larger $\lambda_i$is, then the larger and more negative ln (1 - λ_i) will be; hence, the test statistic will be larger. Each eigenvalue will have associated with it a different cointegration vector, which will be eigenvectors. A significantly non-zero eigenvalue indicates a significant cointegration vector.

λ_{max}conducts separate tests on each eigenvalue, and has as its null hypothesis that the number of cointegration vectors is r against an alternative of r + 1.

$\lambda_{trace}$is a joint test where the null is that the number of cointegration vectors is less than or equal to r against an unspecified or general alternative that there are more than r. It starts with p eigenvalues, and then the largest is removed successively,λ_{trace}= 0 when all the λ_i= 0, for i = 1, . . . , g.

Johansen and Juselius (1990) provide critical values for the two statistics. The distribution of the test statistics is non-standard, and the critical. Values depend on the value of $g-r$, the number of non-stationary components, and whether constants are included in each of the equations. Intercepts can be included either in the cointegration vectors themselves or as additional terms in the VAR.

Osterwald-Lenum (1992) provides a more complete set of critical values for the Johansen test. If the test statistic is greater than the critical value from Johansen's tables, reject the null hypothesis that there are r cointegrating vectors in favour of the alternative that there is r+1 (for λ_{trace}) or more than r(for λ_{max}).

4.7. Diagnostic test

This stage is crucial in the analysis of the impact of oil price volatility on economic growth in South Africa because it validates the parameter estimation outcomes achieved by the estimated model. Diagnostic checks test the stochastic properties of the model. These include the heteroscedasticity residual normality test, and the Lagrange multiplier. The multivariate extensions of these residual tests will be applied in this study. They are therefore briefly discussed herein.

4.7.1 Heteroscedasticity

According to Brooks (2008), there are a number of formal statistical tests for heteroscedasticity. One such popular test is White's (1980) general test for heteroscedasticity. The test is useful because it has a number of assumptions such as that it assumes that the regression model estimated is of the standard linear. After running the regression, residuals are obtained and then test regression is run by regressing each product of the residuals on the cross products of the regressors and testing the joint significance of the regression. The null hypothesis for the White test is homoscedasticity and if we fail to reject the null hypothesis then we have homoscedasticity. If we reject the null hypothesis, then we have heteroscedasticity.

4.7.2 Residual normality test

According to Brooks (2008), one of the most commonly applied tests for normality is the Jarque-Bera (hereafter BJ) test. BJ uses the property of a normally distributed random variable that the entire distribution is characterised by the first two moments: the mean and the variance. It compares third and fourth moments of residuals known as its skewness and kurtosis (Urzua, 1997). Skewness measures the extent to which a distribution is not symmetric about its mean value and kurtosis measures how fat the tails of the distribution are.

This method makes a small sample correction to the transformed residuals before computing the Jarque-Bera statistic. The joint test is based on the null hypothesis that residuals are normally distributed. A significant Jarque-Bera statistic, therefore, points to non-normality in the residuals. However, the absence of normality in the residuals may not render cointegration tests invalid. A more important issue in carrying out the cointegration analysis is whether the residuals are uncorrelated and homoscedastic.

A normal distribution is not skewed and is defined as having a coefficient of kurtosis of 3. It is possible to define a coefficient of excess kurtosis, equal to the coefficient of kurtosis minus 3; a normal distribution will thus have a coefficient of excess kurtosis of zero. A normal distribution is symmetric and said to be mesokurtic.

4.7.3 Lagrange Multiplier (LM) test

The Lagrange Multiplier (LM) test used in this study is a multivariate test statistic for residual serial correlation up to the specified lag order. The lag order for this test should be the same as that of the corresponding VAR (Gujarati, 2004). The test statistic for the chosen lag order (m) is computed by running an auxiliary regression of the residuals (u_t) on the original right-hand explanatory variables and the lagged residuals (u_{t-m}). Johansen (1995) presents the formula of the LM statistic and provides detail on this test. The LM statistic tests the null hypothesis of no serial correlation against an alternative of auto correlated residuals.

4.7 Impulse response analysis

Impulse response analysis traces the responsiveness of the dependent variable in the VAR to shocks to each of the other variables. It shows the sign, magnitude and persistence of real and nominal shocks to the balance sheet channel. A shock to a variable in a VAR not only directly affects that variable, but is also transmitted to all other endogenous variables in the system, through the dynamic structure of the VAR. For each variable from the equations separately, a unit or one-time shock is applied to the forecast error and the effects upon the VAR system are observed over time. The impulse response analysis is applied on the VECM and, provided that the system is stable, the shock should gradually die away (Brooks, 2002). There are several ways of performing an impulse response analysis, but the Cholesky orthogonalisation approach to impulse response analysis, which is a multivariate model extension of the Cholesky factorization technique, is preferred in this study. This approach is preferred because, unlike other approaches, it incorporates a small sample of degrees of freedom adjustment when estimating the residual covariance matrix used to derive the Cholesky factor.

4.8 Variance Decomposition

Further information on the linkages in the balance sheet channel can be obtained from a variance decompositions analysis. It measures the proportion of forecast error variance in a variable that is explained by innovations in itself and the other variables. Variance decompositions performed on the VECM give the proportion of the movements in the dependent variables that are due to their 'own' shocks versus shocks to the other variables (Brooks, 2002). Brooks also observed that own series shocks explain most of the forecast error variance of the series in a VAR. The same factorization technique and information used in estimating impulse responses is applied in variance decompositions.

4.9 Conclusion

This chapter discussed the methodology, model specifications, variables analysis and estimation techniques in the investigation of the impact of oil prices volatility on South African economic growth. The cointegration and VECM by Johansen and Juselius (1990) techniques were proposed. The study will use a number of diagnostic tests in order to validate the parameter estimation outcome achieved by the estimation model.

CHAPTER FIVE

Presentation and analysis of results

5.1 Introduction

This chapter presents the regression analysis of the quarterly data from the period 1994 to 2010.The impact of oil price volatility on economic growth in South Africa is estimated using five variables, namely: GDP, Oil prices, GFI, RIR and RER. The previous chapter set the analytical framework and reviewed the model estimation techniques to be used in this study. The chapter is divided into four sections: the chapter begins with a presentation of the results of the stationarity test. This is followed by a presentation of cointegration tests. Upon finding evidence of cointegration, the chapter presents the results of the vector error correlation model (VECM). The last section presents the diagnostic tests in order to establish the robustness of the model as well as the impulse response and variance decomposition results. Concluding remarks are provided towards the end of the chapter.

5.2 Stationary tests results

If the mean and variance are constant over time, then the series is stationary. There are two main ways to test whether the time series is stationary or not; namely, the graphical presentation, which is informal, and the formal test. The study first shows the graphical presentation followed by the formal test. If the graph crosses the mean of the sample many times, it indicates the persistent trends away from the mean of the series. If the mean and variance change, then the series is non-stationary. The formal test is conducted using the Augmented Dickey Fuller (ADF) and the Philips-Peron (PP) tests. The graphical results from the test for stationarity are presented in Figure 5.1(a) which portrays the data in level form and Figure 5.1(b) portrays the differenced data.

Figure 5.1(a) reveals that Gross Domestic Product (GDP), oil prices, Gross fixed investment (GFI), real exchange rate (RER) and real interest rate (RIR) show trendy behaviour. The gross domestic product, gross fixed investment and real exchange rate show a growth trend by upward sloping while real interest rate (RIR) and oil prices show a fluctuating trend. Figure 5.1(b) shows that all the differenced variables fluctuate around the zero mean, hence the variables are integrated of order one I (1) except the dependent variable GDP which is integrated in order of I(2) and oil prices in order of I(0).

Figure 5.1(a) Plot of variables in levels from 1994Q1 to 2010Q4

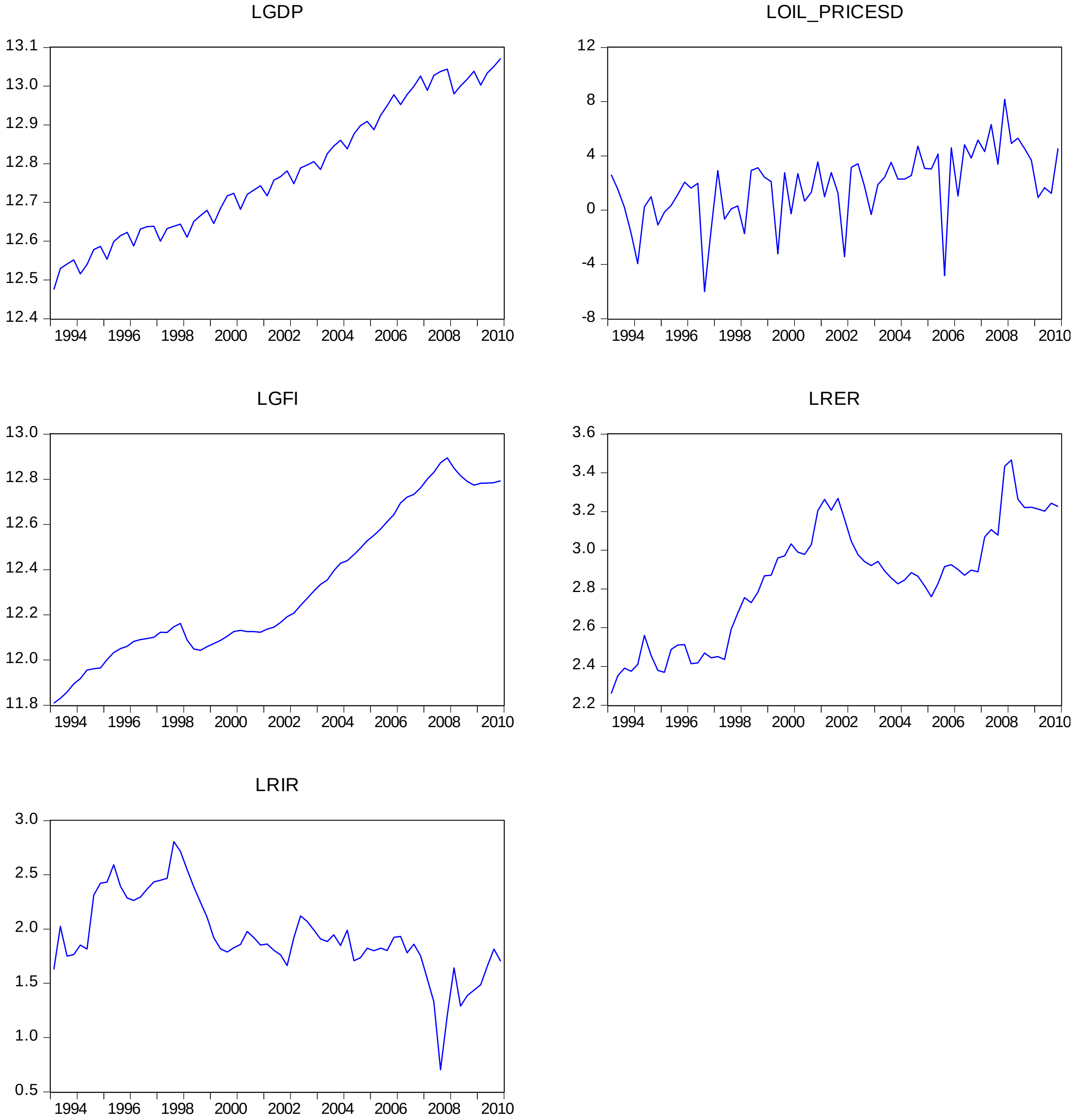


Figure 5.1 (b) Plot of first in differenced variables from 1994Q1 to 2010Q4

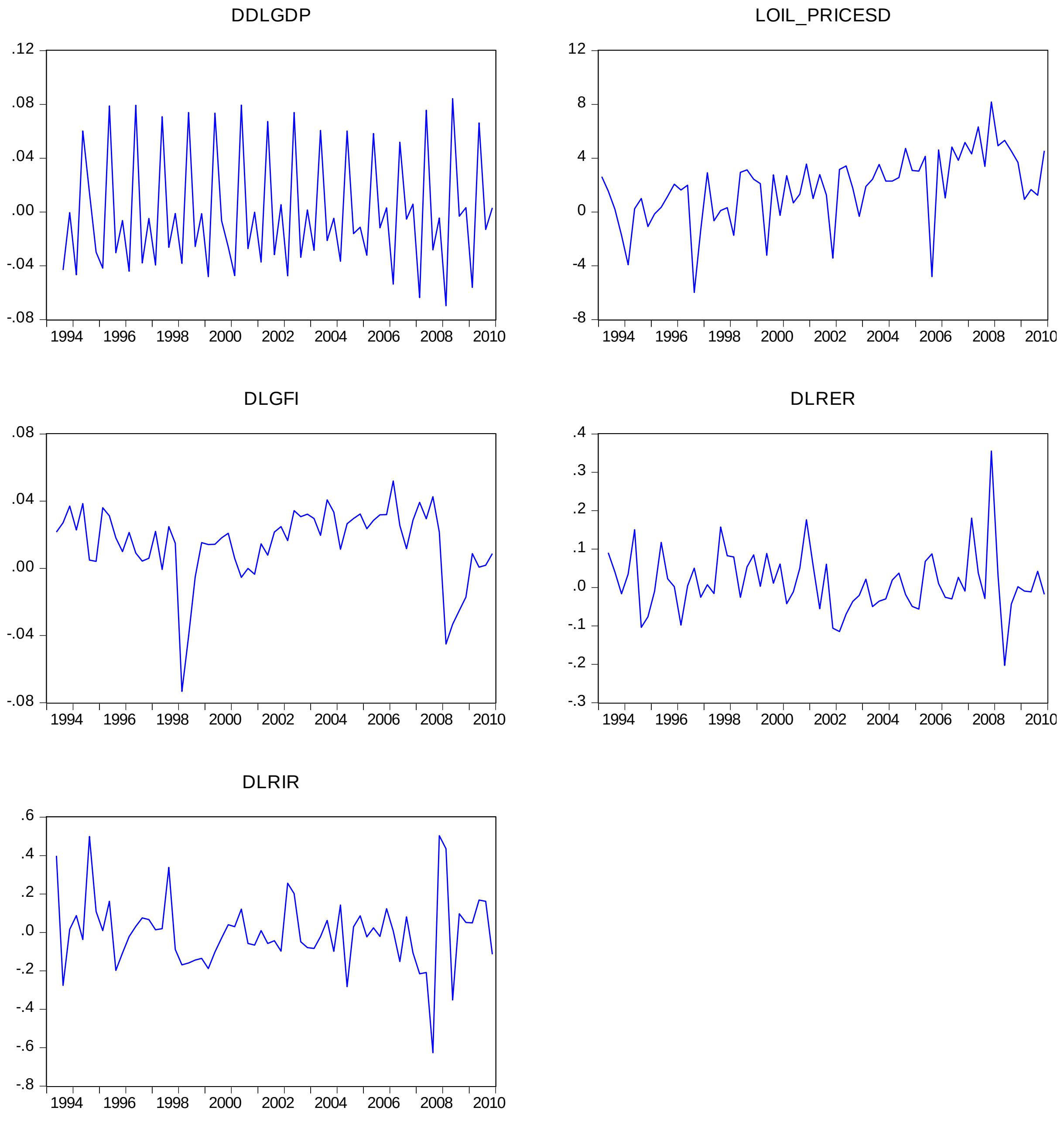


Figure 5.1(b) shows the differenced variables fluctuating around the mean. This means that the series is stationary after differencing and the means are fluctuating around zero. This implies that the data is stationary after it has been integrated. The rational is to avoid the spurious regression problems. However, a decision on stationarity cannot be based on the graphical presentation alone. This needs further formal tests which include the ADF and PP test to support the graphical presentation of results. These formal tests are presented in Tables 5.1(a) and 5.1(b) respectively.

Table 5.1(a): Stationary results from Augmented Dickey-Fuller (ADF) test

Augmented Dickey-Fuller test					
Order of integration	Variables	Intercepts	Trend and intercepts	None	Order of integration
Level	LGDP	-0.596	-2.807	2.480	
1st difference	DGDP	-2.714	-2.676	-1.054	
2nd difference	DDGDP	-7.402	-7.338	-7.467	I(2)
Level	LGFI	-0.648	-1.808	2.202	
1st difference	DGFI	-4.094	-4.064	-3.339	I(1)
Level	LOIL-PRICE	-3.542	-8.226	-2.556	I(0)
Level	LRER	-1.613	-2.06	1.268	
1st difference	DRER	-7.200	-7.154	-7.096	I(1)
Level	LRIR	-2.124	-3.478	-0.3432	
1st difference	DRIR	-8.583	-8.514	-8.651	I(1)
1%	Critical values	-3.5401198	-4.110440	-2.60274	
5%		-2.909208	-3.482763	-194161	
10%		-2592215		-1613398	

Table 5.1(b): Stationary results from Philips-Peron (PP) test

Philips-Peron					
Order of integration	Values	Intercepts	Trend and intercepts	None	Order of integration
Level	LGDP	-0.519	-4.661	5.751	
1st difference	DGDP	-17.150	-18.106	-9.901	I(1)
Level	LGFI	-0.625	-1.494	3.496	
1st difference	DGFI	-4.171	-4.142	-3.339	I(1)
Level	Loil price	-6.45	-8.24	-4.68	I(0)
Level	LRER	-1.648	-2.139	1.259	
1stdifference	DRER	-7.155	-7.104	-7.056	I(1)
Level	LRIR	-2.156	-3.505	-0.343	
1stdifference	DRIR	-8.583	-8.514	-8.651	(1)
1%	Critical values	-3.533204	-4.1009335	-2.600471	
5%		-2.906210	-3.478305	-1.945823	
10%		-2.590628	-3.166788	-1613589	

Table 5.1(b) show the formal tests. Table 5.1 (a) shows the ADF test results which have a null hypothesis of the unit root test. The calculated value of ADF was compared with critical values. If the ADF value is greater than the critical value, then we reject the null hypothesis and, therefore, the series data is stationary. The results carried above were intercepts, trend and none. The results from the ADF test show that the LGDP is not stationary at levels but become stationary after second differencing and the LOIL- PRICESD series are stationary at levels. The results also show that all other variables are also non stationary in levels but they become stationary in their first difference. This means that LGDP is integrated to order I (2) while other LOIL-PRICESD is integrated in order I(0) and the other remaining variables are integrated in order I(1).

Table 5.1(b) shows the Philips-Peron (PP) test results. The null hypothesis is that there is unit root. Applying the PP test to the variables was found to be stationary at first difference while they were all non-stationary at level. The calculated value of PP was compared with the critical values. The results carried above were intercepts, trend and none. Based on the results, it can be concluded that the series is integrated in first order except for oil prices which were stationary at levels. Thus, the variables are integrated of the same order, so can carrying on with the cointegration tests.

5.3 Cointegration analysis

The cointegration approach allows an integration of the long run and short run relationship between within a unified framework. According to Brooks (2008), if the series appears to move together overtime, it indicates an equilibrium relationship. For example, if variables are integrated of the same order it is very important to determine whether the long run relationship exists among them. Cointegration describes the existence of a stationary relationship between two or more series each of which is individually non stationary. In this dissertation, cointegration examines the long run relationship between the gross domestic product and its determinants. It is very important to assess whether there long run relationships exist between gross domestic product and the chosen explanatory variables, in order for a viable economic conclusion to be reached from the results obtained. The Johansen cointegration approach is preferred over the Engle and Granger residual-based methodology to test for cointegration, for obvious reasons as mentioned in Chapter Four of this study. This approach has been shown to be superior to Engle and Granger's (1987) residual-based approach. Among other things, the Johansen approach is capable of detecting multiple cointegrating relationships.

The cointegration test, using the Johansen test, requires the estimation of a VAR equation. The variables i.e. DDLGDP, LOIL-PRICESD, DLGFI, DLRER and DLRIR are entered as endogenous variables. Table 5.2 below presents the pair-wise correlation test result which is used to guide the variables selection exercise. The pair-wise correction matrix is adopted in this study to determine the exact relationship between the five variables used in the study.

Table 5.2 Pair-wise correlation results

Variable	DDLGDP	LOIL PRICESD	DLGFI	DLRER	DLRIR
DDLGDP	1.00	0.122311	-0.076075	-0.090869	-0.077069
LOIL_PRICESD	0.122311	1.00	-0.025270	0.011667	0.002694
DLGFI	-0.076075	-0.025270	1.00	0.090939	-0.090078
DLRER	-0.090869	0.011667	0.090939	1.00	0.152608
DLRIR	-0.077069	0.002694	-0.090078	0.152608	1.00

Table 5.2 shows the pair-wise correlation results; the results reveal that LOIL-PRICESD is positively correlated with the dependent variable DDLGDP. DLGFI, DLRER and DLRIR are negatively correlated with the dependent variable DDLGDP. The positive correlation of OIL-PRICESD to the dependent variable is validated by the theoretical and empirical underpinning which holds that the decrease stimulates economic growth as cost of production decreases and therefore encourages business investment (Hamilton, 1983). The negative correlation between the variable DLRER and DLRIR with the dependent variable DLGDP is in line with theoretical underpinnings which suggest that increases in interest rates and real exchange rates will discourage investment and exports, respectively, thus reducing economic growth (Appleyard and Field, 2005). The results also show that there is no multicollinearity problem among the variables.

Using the Johansen test, there is a need to determine optimal lag-order criteria. It eliminates the serial correlation in the residuals as well as determining the deterministic trend assumption for VAR model. The information criteria approach is applied in this study as a direction in choosing lag-order. Table 5.3 confirms the lag-order selection by different information criteria.

Table 5.3 Lag-order selection criteria

Lag	Log L	LR	FPE	AIC	SC	HG
0	-106.5249	NA	2.66e-05	3.656556	3.829578	3.724365
1	-49.23721	103.3057	9.27e-06	2.597941	3.636076	3.004796
2	-17.03805	52.78552	7.45e-06	2.361903	4.265150	3.107803
3	84.48475	149.7877*	6.32e-07*	0.147041*	2.621318*	0.937905*
4	103.1684	24.50313	8.46e-07	0.060053	3.693524	1.484044
5	125.1347	25.20723	1.08e-06	0.159518	4.658102	1.922555

*Indicates lag-order selection by the criteria

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

FPE: Final prediction error

AIC: Akaike information criteria

SC: Schwarze information criteria

HQ: Hannan Quinn information criteria

Table 5.3 confirms that the criteria selected 3 lag. The Johansen cointegration approach is based on the trace and maximum eigenvalue test. The trace test is shown in Table 5.4(a). The null hypothesis is that there is no cointegration. The null hypothesis cannot be rejected if the test statistic is smaller than the critical values of the trace test. Table 5.4(b) represents the maximum eigenvalue test. The null hypothesis cannot be rejected if the test statistic is smaller than the maximum eigenvalue.

Table 5.4(a) Cointegration Rank test (Trace)

Hypothesis No. of CE(s)	Eigen-value	Trace statistics	Critical values	Prob **
None*	0.577587	131.0836	69.81889	0.0000
At most 1*	0.418208	77.65369	47.85613	0.0000
At most 2*	0.337890	44.07188	29.79707	0.0006
At most 3*	0.172505	18.50779	15.49471	0.0170

The trace test indicates 4 cointegrating eign(s) at the 0.05 level

*denotes rejection of the hypothesis at the 0.05 levels

**MacKinnon-Haug-Michelis (1999) p-values

Table 5.4 (b) Cointegration Rank Test (maximum Eigenvalue)

Hypothesis no. Of CE(S)	Eigenvalue	Maxi-eigenvalue	Critical	Prob**
None*	0.577587	53.42987	33.87687	0.0001
At most 1*	0.418208	33.58181	27.58434	0.0075
At most 2*	0.337890	25.56409	21.13162	0.0111
At most 3	0.172505	11.73982	14.26460	0.1208
At most 4*	0.103414	6.767969	3.841466	0.0093

Maximum eigenvalue tests indicate 3 cointegration eigen(s) at 0.05 level.

*denotes rejection of the hypothesis at 0.05 level

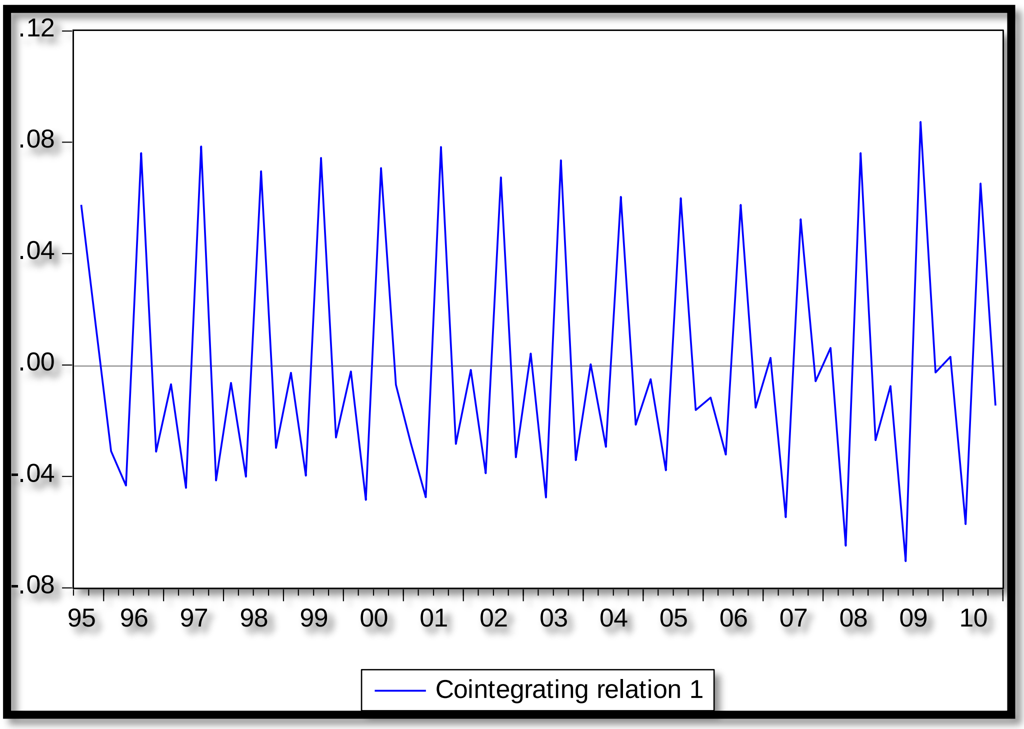
**Mackinnon-Haug-Michelis (1999) p-value

Table 5.4(a) shows that trace test results reflect that at least 4 cointegrated equations exist at 5 percent level of significance. The null hypothesis of no cointegrating vectors is rejected since the trace test statistics of 131.08 is greater than thecritical69,819 at 5% level of significance. Using a similar explanation, the null hypothesis that there is at most 1 cointegration vector can be rejected since the trace test statistic of approximately 77,65 is greater than the critical 47.856 at 5% level of significance. The null hypothesis that there is at most 2 cointegration vectors can be rejected since the trace statistic of about 44.071 is greater than the critical value of 29.798 at 5% significance and even, at most,3 cointegration vectors is rejected since the trace statistic of approximately 18.508 is greater than the critical value of 15.494 at 5% significance. At most 4 cointegration vectors are rejected since the trace statistic of approximately 6.768 is greater than the critical value of 3.841 at 5% significance.

Table 5.4(b) reveals that the maximum eigenvalue test is 3 cointegrating equation that exists at 5% significance level. The null hypothesis of no cointegrating vector is rejected since critical about the eigenvalue of 53.430 is greater than the critical value 33.88 at 5% significance. Using the same analysis, the null hypothesis that there is at most one cointegrating vector is rejected since the test statistic of about 33,581 is greater than the critical value of 27,58 at 5% significance. At most 2, the null hypothesis is rejected since the statistic value of 25.564 is greater than the critical value of 21.131 at 5% significance. At most 3, the null hypothesis cannot be rejected since the statistic value of approximately 11.740 is less than the critical value 14.264 at 5% significant. At most 4, the null hypothesis of approximately 6.797 is greater than the critical value of 3.841 at 5% significance.

Based on the cointegration test results, using the trace and eigenvalues, it can be concluded that there is a long run relationship among the variables. This implies that VECM can now be run. It is therefore required that cointegration vectors be stationary. Figure 5.2, below, portrays a stationary cointegration vector.

Figure 5.2 Cointegration vector



5.4 Vector Error Correlation Model (VECM)

The existence of cointegration means that VECM can be used. VECM techniques allow the long run and short run impacts of variables so as to establish the influence of that impacts oil price volatility on economic growth. Using the results from the cointegration test, the VECM was specified. The VECM results are presented in Tables 5.5 and 5.6, below.

5.4.1 Long-run and short-run cointegration equation

In econometric analysis, a cointegrated set of time series variables must have an error-correlation representation, which reflects the short-run adjustment mechanism. The focus of this section is to examine the influence of the estimated long-run equilibrium on the short-run dynamics, i.e. the cointegrating vectors. Thus, the parameters of the error-correlation term implied by cointegrating vectors for GDP is investigated to determine if they are appropriately signed and significant.

Table 5.5 Results from the long run and short-run cointagretion equation

Variables	Coefficient	Standard error	t-statistic
Constant	-0.001205	-	-
DDLGDP	1.000000	-	-
LOIL-PRICESD	0.000291	0.00019	1.56246
DLGFI	-0.00714	0.01997	-0.35750
DLRER	-0.008308	0.00936	0.88791
DLRIR	-0.00263	0.00450	-0.50295
Short-run Analysis			
Variable	Coefficient	Standard error	t-statistics
DDLGDP	-3.234702	0.57540	-5.62165
LOIL-PRICES	-324.8129	134.8129	-2.40732
DLGFI	2.434042	1.434042	2.38271
DLRER	2.919667	4.59364	0.63559
DLRIR	-26.72993	11.3549	-2.35403

The long run impact of oil price volatility (Loil-pricesd), GFI, RER, RIR on GDP are presented in Table 5.5 above. The cointegration vector indicates a stationary long run relationship which the level of DLGDP depends on the oil price volatility, gross fixed investment, real exchange rate and real interest rate. Table 5.5 shows that oil price volatility has a positive long run relationship with the dependent variable GDP and is significant because the absolute t-value is above 2. The rest of the other variables, namely, GFI and RER, have a negative relationship with the dependent variable and they are statistically significant while the RIR has a positive relationship with the dependent variable but is not significant.

In Table 5.5, the coefficient of DDLGDP of -3.235 shows that the speed of adjustment is approximately 323.5 per cent. This means that if there is a deviation from equilibrium, only 323.5 per cent is corrected in one quarter as the variable moves towards restoring equilibrium. This means that there is significant pressure on economic growth to restore long run equilibrium whenever there is a disturbance. This speed of adjustment is statistically significant with an absolute t-value of approximately -5.621. The high speed of adjustment by economic growth may reflect that the model is well fitted.

The results indicate that a 1% increase in oil price volatility causes GDP increase by approximately 0.029% in long-run. The effect is significant since the t-statistic is approximately 2. According to Katsuya (2005),the analysis leads to findings that a 1% increase in oil price leads to 0.46% GDP decline in the short run while, in the long run, it causes GDP growth. Oil price is determined by the demand and supply. Where the economy grows and there is too much activity, there is inverse oil which usually leads to an inversion of oil price. In Table 5.5 shows that in the short run the oil price has a negative effect on economic growth. A 1% increase in oil prices will reduce economic growth by 324 per cent. An increase in oil prices can, in the short run, cause inflation which reduces investment in the country; this ultimately leads to a decrease in gross domestic product, in the short run.

The 1% increase on gross fixed investment will result in a decrease in GDP with 0.714 per cent. In the long-run, GFI leads to negative economic growth. This is compatible with theory since private investors pull back in the long-run because they cannot generate profit in government investment. In the short run, the 1% increase on gross fixed investment will result in an increase in economic growth, by approximately 24%, and is statistically significant since t-value is greater than 2. An increase in gross fixed investment stimulates economic activity and therefore increases economic growth in the country. This is compatible with neoclassical growth theory which states that an increase in investment will also cause an increase in economic growth.

The results suggest that a 1% increase in RER, which is a depreciation of the South African rand against its trading partners, reduces economic growth in the long run by approximately 0.831. The real exchange rate has a negative effect on economic growth in the short run. A 1% increase in real exchange rates, which is a depreciation of the South African rand, increases economic growth by approximately 291.97. An increase in exchange rate (depreciation of a currency) will cause local goods to be cheaper abroad; this will increase their demand and lead to an increase in exports. Consequently, it will increase foreign reserves and improve the trade balance and accordingly expand output and employment.

In the long run, 1% increase in RIR increases economic growth by approximately 0.263. An increase in real interest rate in the long run attracts foreign direct investment, especially portfolio investments which improve South Africa's balance of payments accounts, thus increasing economic growth. Real interest rates in the short run have a negative impact on growth. An increase in RIR reduces growth by approximately 26.73, and is statistically significant since the t-value is greater than 2. An increase in real interest rates is expected to lead to a decrease in economic growth due to an inverse relationship between investments and interest rates.

5.5 Diagnostic test

The economic growth model was subjected to thorough diagnostics tests. The model was tested for normality, serial correlation, autoregressive conditional heteroscedasticity and stability. Diagnostic checks are performed to the GDP modelling in order to validate the parameter evaluation of the outcomes achieved by the model. Any problem in the residuals from the estimated model makes the model inefficient and the estimated parameters will be biased. For the purpose of this study, the VAR model was subjected to diagnostic checks. The diagnostic test results are presented in Table 5.7, below, and these assist in checking for serial correlation, normality and heteroscedasticity. These diagnostic checks are based on the null hypothesis that there is no serial correlation for the LM test; there is no normality for the Jarque-Bera test and there is no heteroscedasticity.

Table 5.6 Diagnostic test Results

Test	Null hypothesis	t-statistic	Probability
Lagrange multiplier (LM)	No serial correlation	24.15221	0.5106
White (CH-sq)	No conditional heteroscedasticity	489.3051	0.3745

5.5.1Heteroscedasticity

The results from Table 5.7 show that the test for heteroscedasticity using the white test with no cross-terms produced a Ch-sq of 489.3051 at the probability of 0.3745 which means that the null hypothesis that there is no heteroscedasticity was accepted. The alternative hypothesis was that there is heteroscedasticity. This means that the residuals are homoscedastic.

5.5.2 Residual Normality test

The residual normality test was carried out using the Jarque-Bera (J-B) test. Based on the results from Table 5.7, the Jarque-Bera produced a statistic of 58.45955 with the probability of 0.0000.This indicates that the null hypothesis is accepted at 5 per cent level. Therefore, this shows that the residuals are normally distributed.

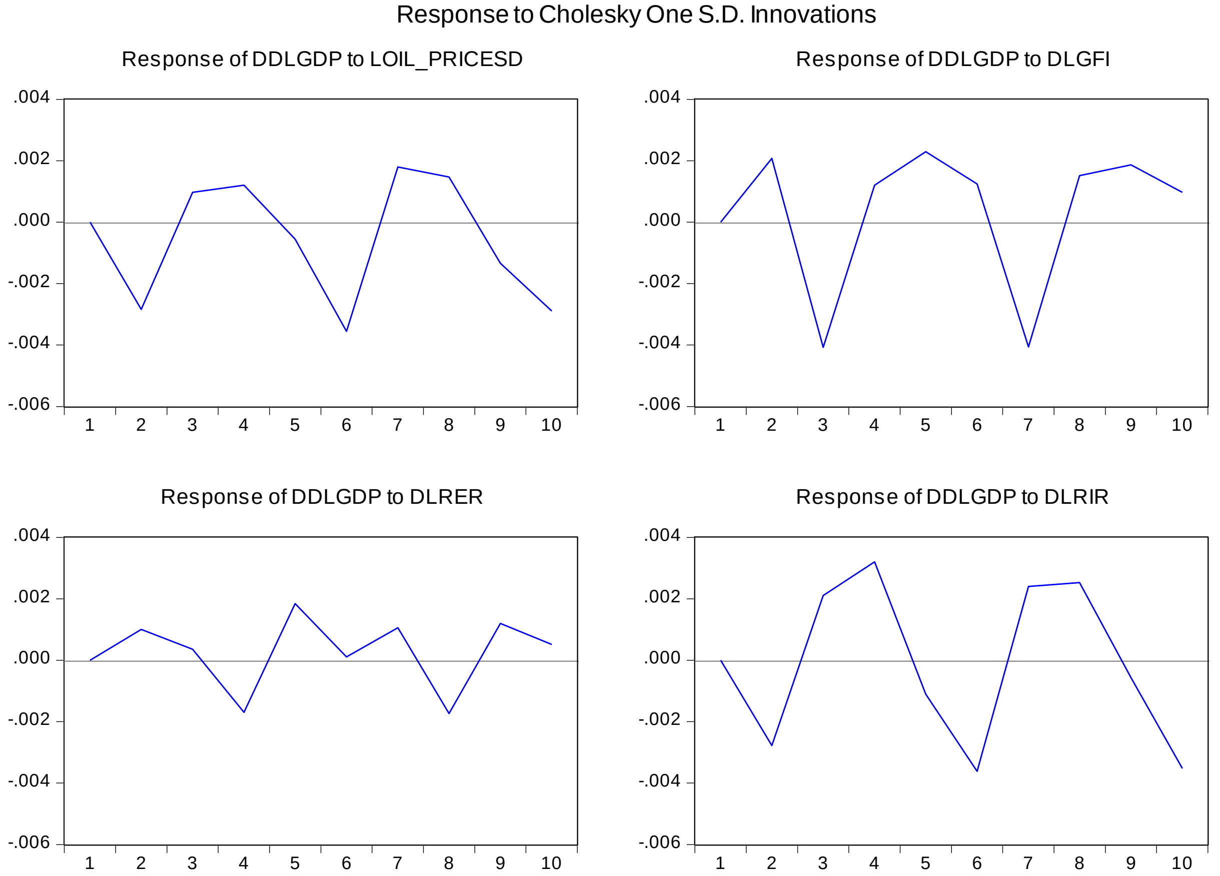
5.5.3 Lagrange Multiplier (LM) test

Table 5.7 shows that the test for serial correlation produced a LM statistic of 24.15221 with the probability of 0.5106; this suggests that the null hypothesis cannot be rejected.

5.6.1 Impulse Response Analysis

The generalized impulse response functions trace the responsiveness of the dependent variable in the VECM to shocks to each of the variables. For each equation, a unit shock is applied to the error, and the effects upon the VECM system over 15 years are noted. However, since our primary objective is to examine the impact of oil price volatility on economic growth of SA, we only trace the responsiveness of the dependent variable, namely GDP. Impulse is portrayed in Figure 5.3, below.

Figure 5.3: Impulse Response Test results



Since this study focuses on the impact of oil price volatility on economic growth, only the responses of economic growth to oil prices and the responses of economic growth to explanatory variables are reported in Figure 5.3 above. These impulse response functions show the dynamic response of economic growth to a one-period standard deviation shock to the innovations of the system and they indicate the directions and persistence of the response to each of the shocks over 10 quarters. For the most part, the impulse response functions have the expected pattern and confirm the results from the short run relationship analysis. Shocks to all the variables are significant, although they are not persistent.

Oil prices show a negative impact from the first quarter onwards, except from the fifth quarter and the eighth quarter. The gross fixed investment shows the positive impact from first quarter except the fourth and eight quarter but all the other quarters reveal a positive relationship with economic growth. The real exchange rate will have a positive impact on economic growth, except in the third and the eight quarter where there is a negative impact.

While the interest rate will have a negative effect on economic growth from the first quarter until ten quarters, except for the fourth and fifth quarters.

5.7 Variance Decomposition Analysis

Variance decomposition provides a tool of analysis to determine the relative importance of the dependent variable in explaining the variations in the explanatory variables. Variance decomposition provides a way of determining the relative importance of shocks in oil prices in explaining variations in economic growth. The result of variance decomposition over a 10-quarter time horizon is summarily displayed in Table 5.8.

Table 5.8 Variance Decomposition of GDP

Periods	S.E	GDP	OIL-PRICE	GFI	RER	RIR
1	0.010564	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.015234	96.36342	1.783953	0.475691	0.058925	1.318008
3	0.016030	87.27163	1.973813	7.544311	0.053583	3.156667
4	0.016429	83.08426	1.977719	7.720680	0.661651	6.555695
5	0.018952	84.84720	1.868866	6.618728	1.069738	5.595470
6	0.021611	84.23713	3.291618	5.151754	1.057605	6.261891
7	0.022032	81.25870	3.813547	7.391321	1.170221	6.366212
8	0.022276	79.49986	3.922246	8.158348	1.500454	6.919093
9	0.024155	81.90014	3.626512	7.102958	1.421198	5.949192
10	0.026100	82.82777	3.880602	6.088053	1.245798	5.957773

The study allows the variance decomposition for 10 quarters in order to ascertain the effects when the variables are allowed to affect economic growth for a relatively longer period of time. In the first year, all of the variance in GDP is explained by its own innovation(Brooks,2008). For the 5th quarter ahead forecast error variance, GDP explains about 85 per cent of its variation while the other variables explain only the remaining 15 per cent; oil-price explains 1.87 per cent, GFI explains 6.62 per cent, RER explains about 1.07 per cent and RIR explains 5.60 per cent.

However, after a period of 10 quarters, economic growth explains about 83 per cent of its own variation, while other variables explain the remaining 17 per cent. The influence of oil price increased about 3.88 per cent, while GFI decreased to about 6.09 per cent, RER increased to 1.25 per cent, and RIR increased to 5.96. These results are similar to those from the impulse response analysis in that all the variables have a significant impact on economic growth in the short run. Economic growth explains most of its variations, followed by gross fixed investment, real interest rates and oil-prices. The real exchange rate does not explain much of the variations in economic growth.

5.8 Conclusion

This chapter was divided into four sections. The first section presented the stationary tests where the Dickey-Fuller and the Philips-Peron tests were used to test stationarity. Both methods revealed that the data series are non-stationary in levels, except oil price, and stationary when first differenced, except GDP.

Then, followed cointegration tests in the second section. The cointegration tests were done using the Johansen maximum likelihood approach. The pair-wise correlation matrix was adopted in the study to determine the relationship between the variables. The results in pair-wise correlation show that all variables are correlated to GDP and confirm that there is no multicollinearity problem. Lag order criteria was applied as a direction in the lag order and the decision to adopt 3 lag order. The trace and maximum eigen value cointegration tests were used to test for cointegration.

The third section presented the VECM model, since variables can either have short-run or long-run effects. In the long-run, only oil price was significant and other variables were insignificant in regards to the effect on economic growth in South Africa. The results show that OIL PRICES have a positive long-run effect on economic growth while GFI, RER and RIR have a negative long-run effect on economic growth.

The last section presented the results of the diagnostic tests carried out in the study. A number of residual diagnostics tests were carried out and these revealed the fitness of the model. Diagnostic checks were performed to the GDP model in order to validate the parameter evaluation of the outcomes achieved by the model. Both the impulse response and variance decomposition were found to be compatible with economic theory. Variance decomposition shows that the GDP itself explains most of its variations, followed by GFI, RIR, OIL PRICE and RER.

CHAPTER SIX

Conclusion and policy recommendations

6.1 Introduction

This chapter provides the conclusion to the study and the relevant policy recommendations born of the study. The first section of this chapter provides the highlights of the main findings in each chapter. The second section provides the conclusion and policy recommendations which arose from the study; it also outlines the, delimitations of the study and offers recommendations for further research.

6.2 Summary of the findings

The first chapter presented the introduction to and background of the study. This chapter included a description of the objectives, hypothesis, problem statement and the organisation of the study.

Chapter Two presented the theoretical foundations and the empirical evidence of the study. Growth theories were discussed herein; these include the Harrod-Domar theory, the neoclassical theory of growth and the endogenous theory of growth. The theories provided the basis of understanding the role of capital, saving and investment. These theories postulate that the production function is a determinant of economic growth. A review of empirical literature shows that oil price volatility affects economic growth negatively, especially in oil importing countries like South Africa, but positively in oil exporting countries.

Chapter Three provided an overview of oil price volatility in relation to South African economic growth. Graphical analysis was used in this chapter to explain the data and to explain the behaviour of oil price volatility as well as the trend of variables over the period of study. The overview of South African economic growth over the period of the study shows that the growth rate was not stable as it was growing at a sluggish rate; it also shows fluctuation over the period. This chapter also showed that the increases in oil price affect the South African economy negatively. In this regard, there is an inverse relationship between oil prices and economic growth in South Africa.

Chapter Four presented the model specifications and the estimations of the model. The variables included in the model are gross domestic product, oil price volatility, real interest rate, real exchange rate and the gross fixed investment. The model employs the ADF and PP unit root tests. Johansen cointegration was employed for the determination of long-run and short-run relationships between the variables which then led to using the Vector error correction model. In this chapter, the diagnostic tests were discussed which include the residual normality test, heteroscedasticity and autocorrelation Lagrange multiplier. The impulse response and variance decomposition tests were also done to check the responsiveness of the dependent variables.

Chapter Five presented the analysis of the results. First, the stationary test showed that the variables were not stationary at level, except the oil price, and the variables became stationary at first differencing, except the GDP, which became stationary at the second differencing. The Johansen-Juselius test was employed and suggested the use of VECM. The model showed that oil price volatility affected economic growth positively in the long-run, while it affected economic growth negatively in the short-run. Diagnostic tests were performed on the residuals. These results show that the residuals were well behaved. The impulse response analysis was done to check the responsiveness of the dependent variable to shocks to each of the other variables. The results show that not all shocks to all the variables were significant and they were also not persistent. Variance decomposition analysis was done to check for the variables that explain most of the variations in the dependent variable. It was observed that GDP explains much of its variations followed by gross fixed investment, then oil price volatility.

6.3 Policy Recommendations

Based on the findings, this study proposed the following recommendations:

There are two policy options to respond to oil price shocks in the economy, namely: monetary policy and fiscal policy. The SARB (2008) uses inflation targeting where it employs the interest rate (Repo) to influence monetary policy. Monetary policy is set by the Banks Monetary Policy Committee (MPC), which conducts monetary policy with a flexible inflation-targeting framework. This allows for inflation to be maintained within a target range. Oil price shocks inevitably lead to high rates of inflation. Monetary policy intervention, in cases where inflation is high, may be commendable (Huang, 2010).However, exclusive use of a monetary policy to curb inflation during oil price shocks may result in unintended consequences such as the depreciation of the rand, which makes oil importing even more expensive.

According to Eltony (2011), fiscal policy can be used more effectively to stabilize the domestic economy after an oil shock. It also indicates that government expenditure should be used properly in order to control domestic prices (CPI) and the balance of payment problems, which is the level of imports.

Since the results show that government expenditure in terms of gross fixed investment significantly impacted on almost all the other variables, it is important that government spending is not increased rapidly to levels which may become unsustainable if oil prices fall in future. There should be uniformity in how the government spends its money on oil and on other economic activities at the same time so as to have a balance that will not upset both oil importation and other strategic economic activities, since an oil shock may hit at anytime while the government has/is spending more on other activities. Such a situation would impact the economy heavily as the government is forced once again to shift focus to oil importation so as to keep the economy running (Bacon and Kojima, 2008).

Given the economic damage in case of rising oil prices, it seems reasonable to suppose that the country needs to diversify its key industries and enhance the competitiveness of non-energy sectors by increasing foreign direct investment (FDI) from the rest of the world, driven by the improvement of investment environment through the World Trade Organization (WTO) accession (Kojima, 2009).

Apart from monetary and fiscal policy interventions, it is also equally important to promote regional integration. According to Aburto (2010), regional energy integration is required in order to reduce oil dependence by optimizing electricity supplies across the region; this improves efficiency and, owing to economies of scale, lowers generation costs. In addition, when the consumption profiles of participants are not perfectly correlated, the smoother load pattern that arises means less investment in reserve requirements. If these conditions are met, the use of fossil fuels, along with the economy’s vulnerability to high and volatile oil prices declines.

6.4 Delimitation of the study and recommendations for future research

This study is limited to the quarterly data captured during the period 1994 to 2010 and did not include any data from before the implementation of inflation targeting policy in South Africa. It is recommended that future studies engage in a comparative analysis of the impact of oil price shocks between the period before inflation targeting and the period after the imposition of inflation targeting policy in South Africa.

6.5 Conclusion

The null hypothesis presented in this study was that oil price volatility has a negative impact on economic growth in South Africa. Given the regression results, the null hypothesis cannot be rejected.

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APPENDIX 1

Obs	LGDP	LOIL_PRICESD	LGFI	LRER	LRIR
1994Q1	12.47520	2.620311	11.80882	2.260617	1.627278
1994Q2	12.52968	1.549454	11.83046	2.350804	2.025513
1994Q3	12.54093	0.208720	11.85761	2.391328	1.749200
1994Q4	12.55166	-1.735001	11.89464	2.374813	1.764731
1995Q1	12.51567	-3.932226	11.91741	2.410183	1.851599
1995Q2	12.53979	0.244435	11.95596	2.560323	1.814825
1995Q3	12.57814	1.001551	11.96081	2.456250	2.313525
1995Q4	12.58667	-1.089454	11.96499	2.379824	2.422144
1996Q1	12.55339	-0.145141	12.00103	2.369963	2.431857
1996Q2	12.59892	0.347907	12.03224	2.487237	2.593013
1996Q3	12.61407	1.164431	12.05032	2.510168	2.394252
1996Q4	12.62278	2.059239	12.06030	2.512279	2.286456
1997Q1	12.58733	1.621860	12.08159	2.414395	2.263844
1997Q2	12.63122	1.986504	12.09066	2.418767	2.294553
1997Q3	12.63723	-5.991465	12.09496	2.469116	2.369309
1997Q4	12.63841	-1.346689	12.10092	2.443911	2.435366
1998Q1	12.60007	2.907906	12.12286	2.450746	2.449279
1998Q2	12.63260	-0.657008	12.12213	2.435279	2.468100

1998Q3	12.63873	0.097580	12.14698	2.592565	2.806386
1998Q4	12.64374	0.314007	12.16191	2.675183	2.717340
1999Q1	12.61048	-1.735001	12.08866	2.754934	2.548664
1999Q2	12.65114	2.935749	12.04802	2.729485	2.388763
1999Q3	12.66615	3.124693	12.04294	2.782972	2.244956
1999Q4	12.67983	2.429825	12.05824	2.867899	2.109000
2000Q1	12.64538	2.115581	12.07236	2.870962	1.919859
2000Q2	12.68437	-3.218876	12.08659	2.959846	1.818077
2000Q3	12.71686	2.752488	12.10465	2.971286	1.788421
2000Q4	12.72326	-0.255667	12.12544	3.032305	1.827770
2001Q1	12.68239	2.696146	12.13137	2.990217	1.857859
2001Q2	12.72092	0.672944	12.12594	2.978942	1.978239
2001Q3	12.73219	1.325376	12.12583	3.029119	1.919859
2001Q4	12.74319	3.560048	12.12233	3.205466	1.853168
2002Q1	12.71682	1.001551	12.13680	3.262931	1.862529
2002Q2	12.75767	2.777582	12.14469	3.207491	1.805005
2002Q3	12.76682	1.262544	12.16633	3.268009	1.761300
2002Q4	12.78136	-3.429597	12.19115	3.161924	1.663926
2003Q1	12.74838	3.157957	12.20760	3.047043	1.919859
2003Q2	12.78925	3.420376	12.24192	2.977976	2.121063
2003Q3	12.79642	1.767535	12.27269	2.941593	2.071913
2003Q4	12.80507	-0.325038	12.30491	2.921009	1.991976

2004Q1	12.78517	1.887812	12.33451	2.942437	1.908060
2004Q2	12.82588	2.435751	12.35409	2.892481	1.885553
2004Q3	12.84541	3.526034	12.39478	2.856700	1.947338
2004Q4	12.86018	2.301144	12.42822	2.827077	1.848455
2005Q1	12.83821	2.294805	12.43947	2.846768	1.990610
2005Q2	12.87647	2.561868	12.46596	2.884018	1.708378
2005Q3	12.89852	4.721708	12.49555	2.865624	1.736951
2005Q4	12.90925	3.082318	12.52792	2.816187	1.822935
2006Q1	12.88778	3.039026	12.55153	2.760010	1.800058
2006Q2	12.92464	4.133726	12.57999	2.828142	1.822935
2006Q3	12.94966	-4.815891	12.61184	2.915498	1.801710
2006Q4	12.97775	4.603169	12.64383	2.925793	1.924249
2007Q1	12.95225	1.037588	12.69582	2.900487	1.931521
2007Q2	12.97853	4.826463	12.72118	2.870962	1.780024
2007Q3	12.99951	3.836784	12.73283	2.897568	1.860975
2007Q4	13.02623	5.164974	12.76150	2.888314	1.754404
2008Q1	12.98924	4.312805	12.80080	3.068704	1.539015
2008Q2	13.02780	6.322493	12.83035	3.106334	1.329724
2008Q3	13.03822	3.391231	12.87297	3.077865	0.703098
2008Q4	13.04414	8.176988	12.89449	3.433503	1.205971
2009Q1	12.98033	4.924299	12.84940	3.465955	1.640937
2009Q2	13.00081	5.314917	12.81609	3.263084	1.289233

2009Q3	13.01813	4.538057	12.79097	3.219915	1.386294
2009Q4	13.03859	3.681099	12.77387	3.222071	1.437463
2010Q1	13.00296	0.940007	12.78254	3.212858	1.486140
2010Q2	13.03351	1.665818	12.78316	3.201241	1.654411
2010Q3	13.05107	1.241153	12.78501	3.243412	1.816452
2010Q4	13.07158	4.550428	12.79374	3.225335	1.702928