

MONETARY POLICY AND ASYMMETRIC EFFECTS OF OIL PRICE  
SHOCKS IN SOUTH AFRICA

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## **Abstract**

This study employs the Structural Vector Autoregressive (SVAR) model to examine the asymmetric effects of oil price shocks on monetary policy in South Africa using monthly data from 1994:1 to 2013:12. A seven variable SVAR with short-run restrictions on the contemporaneous relationships among the variables is constructed for the analysis. Consistent with the existing theory and empirical literature, the study finds that the response of output and inflation to an oil price shock is asymmetric. The nature of the asymmetry, however, is different to what has been reported in most empirical studies. This study finds that a negative oil price shock tends to stimulate output while a positive oil price shock has an insignificant effect on output. Similarly, it is observed that a negative oil price shock reduces inflation by a larger margin than a positive oil price shock increases the general price level. The study results also show that the response of interest rates, money supply, exchange rates, real output and inflation to shocks in the system may be larger or smaller depending on whether oil prices are increasing or decreasing. This underscores that the variables in the monetary policy transmission process respond to shocks asymmetrically. Further investigation reveals that the monetary policy response to increasing and decreasing oil prices is a highly likely source of the asymmetric relationships. It is observed that when crude oil prices are increasing, monetary authorities respond with greater speed and adjust interest rates by larger margins than when crude oil prices are decreasing, which probably explains why increasing crude oil prices tend to have a smaller impact on inflation than decreasing oil prices. It is further observed in the study that exchange rate variations account for a very large proportion of the fluctuations in inflation rates. It is also found that money supply accounts for a larger proportion of the fluctuations in real Gross Domestic Product (GDP) than exchange rates, indicating that money supply may be a more important intermediate target of monetary policy than exchange rates in the transmission of monetary policy where the policy goal is real GDP. In addition, it is found that the proportion of fluctuations in money supply explained by interest rates variations is larger than the proportion explained by exchange rates; and the impact of the interest rates on money supply is also observed to be larger when oil prices are decreasing than when they are increasing. We, therefore, conclude that the money effect, interest rate and exchange rate are important channels of monetary transmission in South Africa. The study results further reveal that in South

Africa, the contribution of the monetary policy goals (inflation and real GDP) to variations in money supply (an intermediate target of monetary policy) may be higher or lower depending on whether crude oil prices are increasing or decreasing. Fluctuations in the rate of inflation account for a higher proportion of the variations in money supply when oil prices are decreasing than when they are increasing; while real GDP fluctuations account for a higher proportion of the variations in money supply when crude oil prices are increasing than when they are decreasing. Similarly, it is observed that exchange rates respond asymmetrically to monetary policy in the event of an increase or a decrease in crude oil prices. The study also reveals that the largest proportion of the fluctuations in interest rates is explained by exchange rates, indicating that monetary authorities respond to exchange rate fluctuations by adjusting interest rates. The impact of this response is observed in money supply variations, as argued in the foregoing discussion. This shows that the monetary policy asymmetry observed in the operating tools and the goals of monetary policy can also be traced through the intermediate targets.

Keywords: Monetary policy; Asymmetric oil price shocks; SVAR

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# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the study

A considerable body of the literature proposes that increasing oil prices tend to decelerate economic growth more than falling oil prices accelerate it (see Hamilton, 1983; Mory, 1993; Jimenez-Rodriguez and Sanchez, 2005). Therefore, the nature of the correlation between economic growth and oil prices is said to be asymmetric. While it is generally agreed that the aggregate economic activities respond asymmetrically following an oil price shock, considerable debate remains with regards to which transmission channels are responsible for this relationship. One of the earliest research on the effect of rising oil prices on economic growth was carried out by Hamilton (1983). Hamilton (1983) found a significant inverse correlation between an oil price shock and real GDP growth in the US, which revealed that oil prices granger causes economic activities. To confirm Hamilton's (1983) findings, Mork (1989) extends the pioneering analysis to include the 1986 fall in oil price. He decomposed oil prices into increasing and decreasing oil prices in order to evaluate the asymmetry specification on US data using real Gross National Product (GNP) growth as a variable measure of economic performance. The asymmetric specification was rationalized in terms of the dispersion hypothesis formulated by Lilien (1982). This hypothesis relies on the argument that a change in oil price alters the equilibrium allocation across various sectors. According to this argument, in the short run the cost of reallocation of resources between sectors is high and oil shocks that imply readjustment between energy efficient and energy-intensive sectors will give rise to an overall loss in output. While this loss will aggravate the economic contraction when oil prices decline, it will constrain the economic expansion when oil prices decline, thereby giving rise to the asymmetric effect. Mork (1989) found that the correlation between oil prices and real GNP growth is asymmetric. The conclusion from Mork (1989) is that the correlation between oil prices and real GNP growth is asymmetric.

Further analyses on the asymmetric impact of oil price shocks have been carried out on other countries besides the US. For instance, Cunado and Perez de Gracia (2003) investigated the impact of oil price shocks on industrial production with a focus on 14 European countries. Their

findings show that in the short-run there is an asymmetric reaction on GDP growth but a permanent effect on consumer prices by oil prices. Sometimes it relies on whether a nation is a net oil importer or exporter. Jimenez-Rodriguez and Sanchez (2005) apply a multivariate regression for Norway and the G-7 countries to explain the inverse relationship between oil prices and Real GDP, the findings reveal an asymmetric relationship. Huang et al (2005) carry out a multivariate threshold model to examine the impact of oil price uncertainty on economic activities. Their results show that an asymmetric relationship is present. In the case of South Africa, sharp increasing oil prices fluctuation may crush the positive effects of any decreasing oil prices (Aye et al, 2014). In other words, the reaction of manufacturing production to increasing and decreasing oil price shocks is asymmetric.

Nonetheless, several linkages have been suggested to be responsible for the asymmetric correlation between oil price shocks and economic activities. These include classic supply shock, adjustment costs and monetary policy. Empirical studies in the 1970s report that monetary policy was significantly restricted to oil price changes (Mork and Hall, 1980; Hickman et al, 1987). Bohi (1991) however disagrees with this finding on the basis that the response of a classic supply shock elucidates the main consequences of rising oil prices to affect mostly oil-intensive industries. He found that in the four countries the restrictive majors executed by the reserve banks are responsible for the fall in GDP after oil prices increase. Bernanke et al, (1997), Hoover and Perez (1994), and Tatom (1988) support this finding since monetary policy makers would respond to some extent to both the recessionary and inflationary effects of positive oil prices. On the other hand monetary authorities might focus on the initial impact of the shock on inflation rate. Given the initial oil price shock, an unconstrained interest rate would consequently stabilize inflation rates but at the cost of reducing real GDP. On the contrary if policy makers are more concerned about output stability. Central banks constrain interest rates which temporarily offset the losses in output. This then shows the importance of the monetary policy response towards oil price shocks.

This conclusion was challenged by Hamilton and Herrera (2004) as their study reflects that counter inflation is a partial reaction towards the effect of oil price shocks by the monetary authorities. Brown and Yucel (1999) argue that the response of monetary policy does not worsen the effect of a past oil price shock. Furthermore, the monetary policy role of explaining the effect

of oil price on economic activities is gradually replaced by real business cycle theory. Ferderer (1996) contends that the monetary policy is not likely to respond asymmetrically to real GDP after an oil price shock. The reason for this conclusion is that uncertainty and financial stress are said to be accountable for these effects. For a decade, the US GDP has been reduced more by increasing oil prices than decreasing oil prices have stimulated its growth. This asymmetric response was caused by the elimination of federal funds expectations (Balke et al, 2002). For this research, the exact channels through which oil prices affects the economy is not crucial. Therefore, an emphasis is given to the asymmetric effects of oil price shocks on real monetary policy in South Africa.

This study is structured as follows. Discussion of the background is presented in chapter one. Chapter two discusses monetary policy in South Africa. Chapter three reviews both theoretical and empirical literature on the correlation between oil price changes and output, inflation and also how monetary policy responds to oil price shocks. Chapter four discusses data sources, variable definitions and the methodological framework characterizing a structural vector autoregressive model. Chapter five analyses the results. Chapter six draws in the summary and conclusion of the study.

## **1.2 Problem statement**

South Africa is a net importer of oil. Accordingly, an upward trend in the price of crude oil leads to increasing concerns about associated macroeconomic implications. Indeed, the South African Reserve Bank (SARB) considers oil price increases to be one of the major threats to the continued attainment of its inflation target, as shown in various recent statements by its Monetary Policy Committee. Furthermore, global oil price shocks (rising energy prices) have the potential to weaken the Government's Accelerated and Shared Growth Initiative for South Africa (AsgiSA), which is aiming at halving unemployment and poverty by 2014 (Wakeford, 2006).

Empirical literature suggests that positive (increasing) oil price shocks have a larger effect on GDP growth than negative (decreasing) oil price shocks (Jimenez-Rodriguez and Sanchez, 2005; Mory, 1993). Thus, the relationship is asymmetric between prices of oil and GDP growth. Furthermore, it has been argued that after a positive oil price shock (an increase in oil prices), a

fall in GDP in oil importing countries is caused by a combination of direct impacts of the shock to its own contemporaneous effects and monetary responses to curtail the shock (Bernanke et al, 1997 and Bohi, 1989). This study, therefore, has identified the trend in the global oil price as a factor that policymakers must focus on and propose appropriate policies. In addition, there is a delay in the response of policymakers to global oil price shocks that impact the economy. Therefore, a counter-cyclical or pro-cyclical response is needed to the asymmetric effects of the oil price shocks that impact the economy. This study, therefore, carry's out an empirical analysis on the asymmetric effects of oil price shocks in South Africa.

### **1.3 Research Questions**

- In a given state of the economy, are the real effects of a contractionary and an expansionary monetary policy different?
- What is the impact of an oil price shock (external shock) on real GDP and inflation?
- How does monetary policy react to oil price shocks that impact the economy in South Africa?

### **1.4 Motivation/significance of the study**

The motivation for carrying out this study can best be linked to its significance to the policymakers and the economy. Firstly, through this study, various strategies that can be used to cushion the effects of the asymmetric oil price shocks and address structural problems (inflation) that can be implemented. Secondly, this research project will suggest monetary policy that will continue to target low and stable inflation while supporting a more competitive exchange rate. Furthermore, the findings of this project will suggest ways in which South Africa can achieve macroeconomic stability.

## **CHAPTER TWO**

### **MONETARY POLICY AND OIL PRICE MOVEMENTS IN SOUTH AFRICA**

#### **2.1 Introduction**

This chapter discusses the evolution of the South African monetary policy. The evolution consists of pre-inflation and inflation targeting monetary policy regimes. Furthermore, it discusses the macroeconomic variables that relate to monetary policy in South Africa.

#### **2.2 Evolution of South African Monetary Policy**

The South African monetary policy has two distinct regimes. The first regime is from the period of 1960 to 1998 where the country adopted a number of monetary policy frameworks. These included exchange rate targeting, discretionary monetary policy, monetary-aggregate targeting and an eclectic approach. The pre-inflation targeting monetary policy regime was characterised by high and volatile inflation (Kumo, 2015). Monetary policy in South Africa since the 1960s has had three broad monetary policy systems. These include the early 1980s quantitative controls on credit and interest rates (liquid asset ratio-based system), after the recommendations of the (1978, 1985) de Kock Commission Reports there was a shift towards cash reserves based system. The third system was initiated from March 1998, with the repurchase interest rate being market-determined in daily tenders of liquidity through repurchase transactions.

Firstly, from the 1960s up to the early 1980s the monetary policy that was adopted was the liquid asset ratio-based system. In this system, the interest rate played a minor role as a monetary policy instrument while the liquid asset requirement was used. The thought behind this strategy was that commercial bank lending and money supply growth would be limited by the limited supply and low yields of these assets (Aron and Muellbauer, 2000). From 1978 to December 1983 there was an upward ratcheting of interest rates when money market shortages were experienced due to the introduction of setting accommodation rates above the money market rates. A large degree of disintermediation brought about by the direct limits on credit extension by the banking system up

to 1980, and the reintermediation when the credit ceilings were abandoned hence, credit extension data was distorted significantly (Van der Merwe, 1997).

In 1985, the cost of cash reserves-based system gradually replaced the liquid asset ratio-based system. The (1978, 1985) De Kock Commission Reports of recommendations were followed by the cash reserves-based system. Under this system the South African Reserve Bank discount rate influenced the price of overnight collateralised lending and hence market interest rates. The supply of credit was influenced by open market operations and various other policies acting on overall liquidity. From 1986, pre-announced monetary target ranges for broad money (M3) followed the De Kock Commission recommendations (1985). The De Kock commission made further recommendations due to the increasing discontentment with the liquid assets ratio system. After the De Kock Commission, there were announcements of M3 guidelines annually from 1986 to 1998 and explicit growth targets (Van der Merwe, 1997). These monetary targets were indirectly influenced by adjusting interest rates. In the 1980s, financial liberalisation and other structural developments led to changes in growth of money supply, output and prices and also significantly reduced the usefulness of money supply targets (Aron and Muellbauer, 2000). These targets were then supplemented by a broader set of indicators which later played a less prominent role which included the output gap, exchange rates, the balance of payments, total credit extension and the fiscal stance.

The target ranges were annually set using a three month moving average of M3 growth, and were announced in the March budget to cover both the previous and current year fourth quarters. The aim of setting the targets was to accommodate both projected real GDP and stabilize inflation, though the procedures used to choose the target were not transparent. This target system was largely diminished by large capital flows from 1994 and in the 1980s it was the extensive financial liberalisation. The guidelines were augmented by an eclectic set of indicators, which included the output gap, exchange rate, balance of payments and fiscal stance (Stals, 1997). During these periods, the policy measures were opaque and this consequently diminished the SARB accountability. For example, the policy actions taken in 1996 and 1998 were extremely debatable, and expensive both to the fiscus and to economic growth (Stals, 1997). Marginal over- or under provision signalled a preference for stabilising the repurchase rate at prevailing levels

while a full provision of the estimated daily liquidity requirements of banks indicated a neutral position on the part of the SARB (Stals, 1999).

Furthermore, the Governor of the Reserve Bank had announced that the inflation rate should be brought down to a level that is in line with the economies of South Africa's major trading partners. The Governor indicated that there would be an informal inflation target range of 1 to 5 per cent that would serve as an important economic guideline for monetary policy decision making (Aron and Muellbauer, 2000). This was a result of the changes in monetary aggregates losing some of their usefulness as the most important indicator of possible future trends in inflation, and also as an anchor for monetary policy decisions. A drawback of the informal inflation target was that it could not be expected to elicit the same commitment to policy co-ordination that would follow if the government had formally endorsed or set the target (Aron and Muellbauer, 2000). Hence, formal inflation-targeting framework improved policy co-ordination, policy focus, transparency and accountability. It also contributed to the move away from the eclectic monetary policy framework. Since the implementation of inflation targeting, monetary policy has been characterised by greater interest rate stability. Hence, South Africa has been more successful than many countries in withstanding inflationary pressures from rising international crude oil prices (Van der Merwe, 1997).

In the early days of the new system, auctions with a predetermined fixed interest rate were used but then discontinued in early 2000 (Van der Merwe, 2004). There was a little difference in interest rate behaviour between the second two regimes even under price auctioning. The disadvantage of this system was that the money market functioned poorly, dominated by a few large banks, rates proved inflexible and the interbank market did not always clear effectively. Therefore, in September 2001 and May 2005 there were changes that helped increase participation in the market. The repo rate was also fixed to remove any ambiguity about SARB policy signals. The SARB has also provided a daily benchmark for money market interest rates.

The main influences of the monetary policy change in South Africa are the greater openness associated with the international reintegration of the democratic South Africa. In the 1990s policy was very opaque and diminished the accountability of the South African Reserve Bank because the set of indicators such as output gap, fiscal stance and wage settlements that had unknown weights (Stals, 1997). In the year 2000, inflation targeting regime was adopted with the

goal of improving transparency, predictability and accountability (du Plessis, 2002; Van der Merwe 2004). The primary purpose of the monetary policy is to maintain price stability which can provide sustainable growth in the economy. The advantage of inflation targeting is that it allows shocks that are outside of the control of authorities to be absorbed.

Inflation targeting aims to attain a rate of increase in the general consumer price index, eliminating the mortgage interest cost of between 3 and 6 percent per year. The Ministry of Finance used to set the target range but now it is set by the National Treasury in collaboration with SARB (Aron and Meullbauer, 2005). The final decision is taken at the cabinet level. The National Treasury and SARB was represented in the inflation targeting technical committee that was inaugurated in 2001. The target has been altered several times depending on the reaction of exogenous shocks. For example, in 2004, 2005 the target was 3 to 5 percent which then increase to 3 to 6 percent after 2006 (Aron and Meullbauer, 2006). The rectification of this policy fault is likely to decrease the interest rate volatility that might ensue from a progressively shortening target horizon (Monetary Policy review, 2004:2).

### **2.3 The reaction of monetary policy to shocks**

Inflation targeting monetary policy in reality has low stable inflation that fails to translate into stronger economic growth that could further lower the unemployment rate in South Africa. This is due to the structural challenges which include skills gap, high level of unemployment, uncompetitive goods and services market, particularly after the 2008/9 global financial crisis. A possible solution could be to increase the inflation targets in order to allow the South African Reserve Bank to decrease the interest rates during severe economic slowdowns (Kumo, 2015).

A floating exchange rate and inflation targeting are viewed as a two-edged sword because it means that external sector shocks can weaken the currency which will increase inflation only in the short run. The period after the implementation of inflation targeting was challenged by the external fall in the exchange rate. Empirically inflation targeting has made the conduct of monetary policy more reliable. As indicated by the following results: the output gap plays a major role during inflation targeting, the short run reaction to inflation is larger than the long run, real exchange rate seems to play a larger role during inflation (Woglom, 2003).

South Africa has a small open economy that is subject to external shocks, which affect inflation. These shocks may cause a movement from the target such as an increase in oil prices or drought affecting food prices. However, the monetary policy has a slight effect in the first instance but is anticipated to respond to the second round effects, and obvious variations induced in inflationary anticipations (Aron and Meullbauer, 2006). Thus, the SARB in consultation with the National Treasury, had a revised escape clause in 2003 for clarity and flexibility.

The repo rate that was announced in October 1999 was around 12% even in May 2001. In order to respond to the rising international interest rates and oil prices in 1999, there was an unscheduled meeting in October 2000. The aim of the meeting was to stabilise inflationary expectation by having the repo rate increased by 25 basis points for the second round effects of external shocks (Aron and Meullbauer, 2006). The oil price shocks in the first round effect might be direct or indirect. For example, if petrol prices were to increase sharply, producers would increase their prices because of the transport cost, which would indirectly affect consumer prices. The direct effect is on consumer transport cost. The second round effects take place when the oil price shock shifts inflation expectations. These are the effects that the monetary policy would seek to counter in the event of an oil price shock (Monetary Policy Review, June 2015).

Due to the deterioration in economic growth, the monetary authorities had to tighten monetary policy since the beginning of 2014. This decision was underpinned by the weak exchange rate which continued to cause a significant risk to the inflation outlook. The rand depreciation was driven primarily by negative sentiments about emerging market currencies following the tapering of quantitative easing by the US Federal Reserve and the renewed fear of an economic slowdown in China (Kumo and Omilola, 2015).

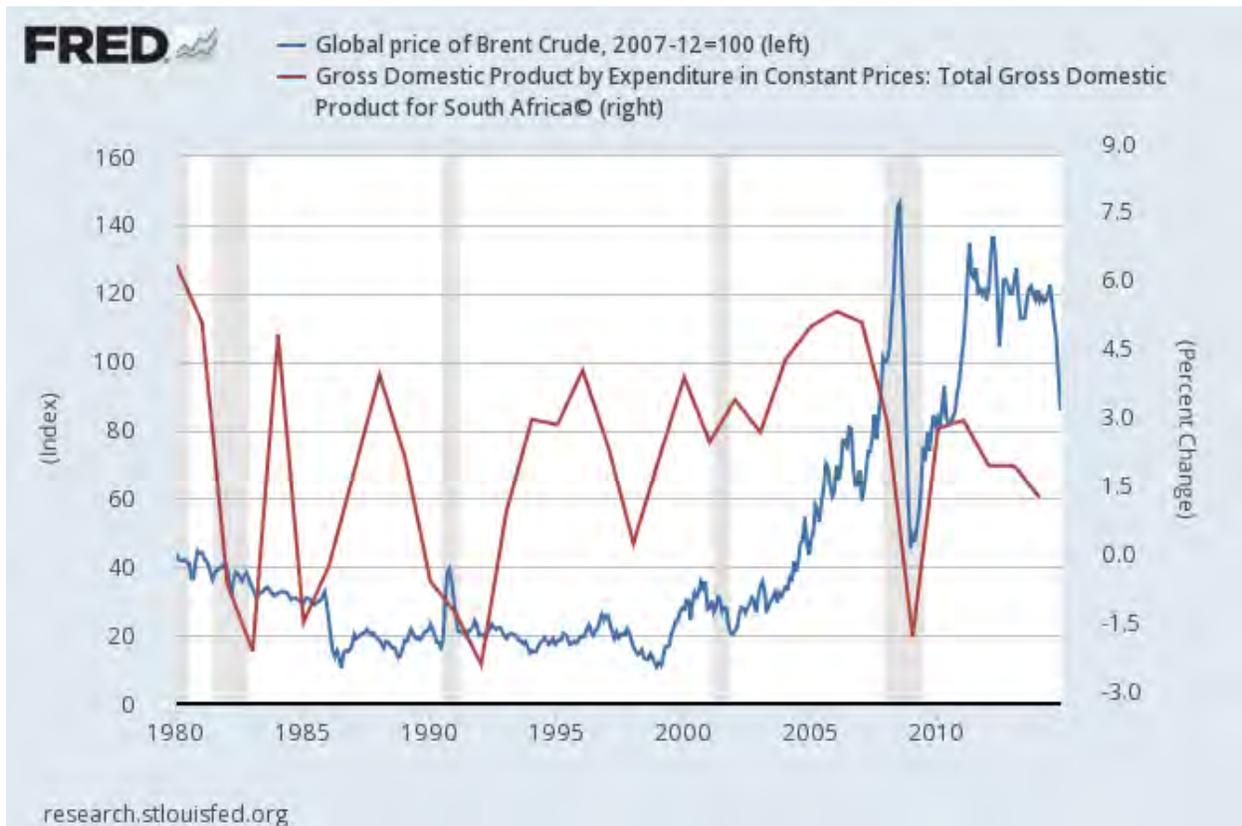
An unanticipated contractionary monetary policy in South Africa reduces output, suggesting that unanticipated monetary policy has significant nominal effects with price levels significantly reduced (Ncube, 2014). Furthermore, a contractionary monetary policy also impacts consumption expenditure in South Africa. An increase in interest rates lowers the amount of disposable household income available after mortgage payments have been made (Ncube, 2014). Monetary policy tightening also impacts both household credit and wealth, which lowers the level of consumption. When interest rates increase with an additional oil price inflation variable, the negative effect on all real consumption, real disposable income and real house prices

becomes stronger (Ncube, 2014). The author used a Bayesian sign restriction to compare the effects of contractionary monetary policy and exchange rate appreciation shocks on the trade balance in South Africa. The results show that trade weighted exchange rate appreciation shocks worsen the trade balance for longer periods than contractionary monetary policy shocks.

## **2.4 Trends in changing oil prices and their relationship with the South African economy**

Economic theory and empirical evidence link rising oil prices to real GDP losses (Brown and Yucel, 2001:20). On the demand side increasing oil prices deteriorates the terms of trade of net oil-importing countries. Therefore, this section discusses the changes in crude oil prices and real GDP. Figure 1 illustrates the changing crude oil prices in relation to real GDP. The figure shows the 1980s oil price shock was a result of the Iranian revolution and the subsequent war between Iraq and Iran. South African GDP worsened (Wakeford, 2006). In 1983 South Africa experienced a severe recession, meaning that the country was not immune to oil price shocks. In the 1990s the oil price shock was triggered by the Iraqi invasion of Kuwait. During this time South Africa's GDP was declining as a result of other factors such as the weak demand of its exports coupled with sanctions. As shown by the figure, increasing oil prices had less of an effect on economic activity. This means that increasing oil prices do not necessarily mean a recession. There are however key differences between this increase and previous oil price shocks. For instance, the oil price increase in 2004 was considerably smaller compared to other increases. This was due to the appreciation of the rand against the US dollar (Swanepoel, 2006).

Figure: 1 Crude oil prices and Real GDP



Source: International Monetary Fund (2015)

Furthermore, from 2006 to 2008 crude oil prices more than doubled which is attributable to strong growth of the economy which led to great demand of oil (Nkomo, 2010). Therefore, an increase of oil is balanced by an increase of export production in a budget constrained economy thereby putting downward pressure on the exchange rate (Swanepeol, 2006). As a result, imports become more expensive and exports less valuable and consequently real national income drops. Lower national income reduces demand for imported and domestic commodities and investment, leading to a drop of GDP.

## **2.5 Conclusion**

This chapter provides a brief overview of the South African monetary policy from 1960-2000. The adoption of inflation targeting monetary policy in South Africa has succeeded in achieving its primary objective of low and stable inflation. However, the spill-over effects of low and stable general price level were limited to the real economic sector.

## **CHAPTER THREE**

### **LITERATURE REVIEW**

#### **3.1 Introduction**

This chapter reviews related theoretical and empirical literature discussing the asymmetric effects of oil price shocks on monetary policy goals (real GDP and inflation). The concept of monetary policy channels or transmission mechanism through which oil price shocks result in an asymmetric response in real GDP and inflation will also be discussed.

#### **3.2 Theoretical Background**

##### **3.2.3 Monetary theory**

“Monetary economics investigates the relationship between real economic variables at the aggregate level such as real interest rate, real output, real exchange rate and nominal variables such as money supply, inflation rate, nominal exchange rate and nominal interest rate” (Walsh, 1998:1). Monetary economics seems to overlap with macroeconomics because in the 1970s the Keynesians and monetarist arguments led to the combined analyses of macroeconomics and monetary economics. However, monetary economics is distinct because it puts more emphasis on inflation and monetary policy. In other words, it determines the relationship between real and monetary factors.

Johnson (1971) discusses the monetary theory basic assumption that money supply has a significant influence on the economy. However, other schools of thought do not agree with this basic assumption. For instance, Keynes states that monetary policy influences aggregate demand through interest rates. The Classical theory focuses on the influence of money on prices while the Keynesian theory concentrates on its influence on real variables. In the case of classical theory, wages and prices are flexible while the Keynesian theory assumes wages to be rigid in which case money influences quantities. The Keynesian theory is applicable in the short run but this does not mean that the long run analysis should be neglected. The final issue is the conflict between those who believe the function of theory is to formulate general equilibrium models of

the economy (the positivist school led by Milton Friedman). According to the positive school the essence of the quantity theory is the velocity relationship between money income and the quantity of money. The Keynesians theory is the multiplier relationship that relates investment to total income. Monetary theory is incomplete without the theory of monetary policy which provides linkages between monetary and real economic phenomena (Lewis and Mizen, 2000).

### **3.2.4 Monetary policy**

Monetary policy is a powerful tool to understand some of the ways that monetary policy can affect the economy (Mishkin, 1995). Monetary authorities are not only concerned with the type of oil price shocks and magnitude of their impact on economic activity, but also with the linkages through which oil price shocks affect real economic variables (Peersman and Van Robays, 2009). Five monetary policy channels provide a possible elucidation for the asymmetric responses of macroeconomic variables to oil price shocks, namely, exchange rate channel, interest rate channel, money effect channel, asset price channel and credit channel.

#### *The exchange rate channel*

The exchange rate channel focuses more on monetary policy operating through exchange rate effects on net exports (Mishkin, 1995). Monetary policy can affect the exchange rate through interest rates. When interest rates increase, domestic currency deposits become more attractive compared to foreign currencies, leading to the strengthening of the local currency. Once the local currency appreciates exports become more expensive relative to imports, thereby causing a decline in output. Conversely, a depreciation of the domestic currency vis-à-vis foreign currencies makes domestic exports cheaper relative to imports thereby causing a growth in output.

#### *The interest rate channel*

The interest rate channel transmits the effects of monetary policy on the economy (Mishkin, 1995). Mollentze (2000) explains that an increase in the REPO rate is transferred to other short-term money market rates, leading to a higher cost of borrowing and hence a decline in

investment and consumption. The central bank lends money to commercial banks and charges interest which fully determines the interest rate in the economy. The commercial banks lend to investors who transmit the interest rate level to output and prices. The main characteristic of this transmission mechanism is that it drives consumption and investment decisions. The monetary authorities react to oil price shocks through operating tools of monetary policy. For instance, a contractionary monetary policy caused by increasing interest rates to check inflationary pressure resulting from increasing oil prices discourages investment and leads to a decline in output.

### *The money effect channel*

The monetarist story states that when money supply falls, the public decreases its spending because they realize that they have less money than they want to hold at a given rate of interest (Mishkin, 1995). In other words, the money effect of monetary policy transmission moderates the influence of liquid asset adjustment and interest rates which then minimize the direct connection between absorption and fluctuations in aggregate money supply (Bolnick, 1991). This approach assumes that output and prices react to monetary impulses because the public and investors incorrectly perceive all the forthcoming outcomes of previous and present activities (Meltzer, 1995). This maybe principally due to the presence of a time lag between detecting the impulses and being able to differentiate between real and nominal shocks, permanent and transitory impulses (Ngalawa and Viegli, 2011).

### *The Asset price channel*

A firm's financial and physical price can be increased by an expansionary monetary policy as the public spends their excess money holdings. Consequently, this puts upward pressure on the price of stocks. Due to expansionary monetary policy, the net worth of a firm increases thus, the value of collateral, a firm's credit worthiness and company cash flow (Norris and Floerkemeier, 2006). This in turn increases investment expenditure and output. Furthermore, consumption, financial wealth and lifetime income increase as well

### *The credit channel*

Agency problems arise in credit markets through the following monetary transmission channels: the balance sheet channel and the bank lending channel (Norris and Floerkemeier, 2006). The balance sheet channel concentrates on the supply of funds from financial intermediaries to borrowers (special role for banks is nonexistent). An example would be the informal financial market (co-operative society). This channel arises from asymmetric information problems in credit markets. However, the channel functions poorly due to practices such as third party lending (Norris and Floerkemeier, 2006).

The bank lending channel is the avenue which makes funds available to borrowers. In this case, monetary authorities increase the money supply through the supply of bank loans, that is, an increase in the quantity of money velocity through loan disbursement instead of the rate of credit. A tight monetary policy will result in a fall of bank deposits, which consequently affects the capacity of banks to provide loans to investors (Mishkin, 1995). This will in turn lead to a decline in output growth. Alternatively, the monetary authorities can reduce the legal reserve requirement of commercial banks so that they may have a greater capacity to lend.

### **3.3 Review of theoretical literature**

The asymmetric relationship between changes in oil prices and the level of economic growth can be explained by the rising scarcity of energy. The high cost of energy lowers firms' profits, making them reluctant to invest in new capital (Van Soest et al, 2000). However, if they perceive that the shock is permanent; firms might invest in energy efficient capital so as to replace the depreciating capital. In the long run high cost of energy may cause a technically and economically obsolescent stock of capital or reduce the firm's investment in new capital (Mishkin, 2007). Therefore, the production levels are more likely to decrease. However, if consumers expect a temporal rise in prices of oil they may choose to borrow or spend more, causing a reduction in real balances and making price levels to rise even further.

The real money balance effect is known as a possible link through which oil price shocks affect economic growth (Mork et al, 1994). A rise in oil prices leads to a rise in money demand. With a

given money supply, interest rates increase, effectively putting downward pressure on GDP. This can be an effect of oil price shocks through income transfer from importing to exporting oil nations. As a result, domestic production in the importing countries is adversely affected, consequently hurting domestic consumption.

However, in the short run there is a probability that consumers might be hesitant to reduce non-energy spending below a certain general level, resulting in decreasing their saving rather than spending (Cognigni and Manera, 2008). Another channel would be the real balance effect. Rising oil prices not only reduce output but inflation also increases. High oil prices are followed by an immediate increase in the production of oil products. Prices of the substitutes of the oil products are also expected to increase in turn. An indirect response to this could be demand for higher wages by workers and an increase in prices (generally) by firms. Due to the reduction in real money balances, household wealth is negatively affected. This in turn reduces household consumption and production. Moreover, a liquidity preference effect is likely to occur as consumers rebalance their portfolios towards liquidity (Mishkin, 2007). If monetary policymakers do not increase the money supply in response to the high demand for money, real balances will fall and the rates of interest will rise.

Monetary authorities can influence the experience of an oil price shock. For instance, if the central bank plans to have an unchanging nominal GDP, the consumer price index will rise at the same magnitude as output slows. In the presence of monetary illusion, contractionary monetary policy will downplay the strength of declining output while the inflationary pressure falls. Without monetary illusion, there will be no real effects but direct changes in inflation. The above description could relate to an oil price shock increasing the rates of interest and the velocity of money. The monetary authorities respond by decreasing the growth of money by further increasing the rates of interest to keep a constant nominal GDP growth rate. If the growth rate of monetary aggregate velocity rises, the nominal GDP growth will increase and consumer price will accelerate more than the GDP growth decelerates. If monetary authorities stabilise the rates of interest, both the monetary aggregate and inflation will rise. The same monetary policy is attainable if the oil prices have no impact on the real interest rate but has an unchanging monetary aggregate, nominal GDP growth and interest rate. The relative purchasing power shifts to oil exporting nations from oil importing nations because of increasing prices of oil that are a

link through which the economy might be affected. This shift results in consumption growth for exporting countries by less than the decrease in consumption of oil-importing nations. Foreign consumption from oil importing nations drops and savings rise. The decrease in international interest rates may cause an inflow of short-term capital that offset the decline in consumption and leaves aggregate demand unaffected in the oil-importing nations (Brown and Yucel, 2002).

In the 1970s, the effectiveness of the reaction of monetary policy to oil price changes was restricted (Mork and Hall, 1980). According to classic supply-side effects, increasing prices of oil tends to reduce the inputs of production thus, output declines. As a result, production costs rise and production and output growth are retarded. Increasing oil prices worsen oil importing countries' terms of trade. Moreover, oil importing countries experience a loss because of the wealth transfer that occurs, resulting in the fall of purchasing power of households and firms. Rising prices of oil may lead to high demand for money. If monetary authorities are not able to meet this, interest rates increase and economic growth slows down (Mork et al, 1994). Furthermore, rising oil prices create inflation and affect consumption and investment negatively. If increasing oil prices occur over a long period of time, it may have an impact on unemployment. This may also cause reallocations across capital and labour sectors.

The relationship between oil prices and output has weakened since the late 1990s (Loungani and Yucel, 2000). The weak relationship also exists between increasing oil prices and core inflation. Hooker (2000) used a Phillips curve framework to investigate the oil price inflation relationship. He found that the structural break provides a better fit to the data than other specifications. He also observed that the hypothesis that oil intensity has declined or deregulation of oil-producing and consuming industries has a vital role does not hold; and neither did monetary policy become less accommodative but may have assisted with the creation of a regime that is slightly sensitive to oil price shocks.

### **3.4 Review of the empirical literature**

Empirical pioneering research on oil price shocks was done by Darby (1982) and Hamilton (1983). Darby (1982) estimated the effect of a positive oil price shock on real income in developed nations, initially working on the US economy. The results showed a statistically insignificant correlation between oil price movements and real income. However, when indirect consequences emerge from variables such as money supply, exchange rates and exports are considered, the results turn out to be significant. Darby (1982) found a negative relationship, showing a causal link from oil prices to output. Hamilton (1983), on the other hand, found a strong significant link between real GNP growth and oil price changes in the US. His analysis was carried out during the time periods 1948-1972 and 1973-1980 in which there were great increases in oil price changes. Mork (1989) expands Hamilton's analysis using the same model but added downward oil price movements and a variable of oil prices that was adjusted for the effects of price controls. Hence, he allowed real increases and decreases in oil price to have different coefficients in a regression equation with real GNP growth as the dependent variable. The coefficients on oil price increases now turn out to be negative and highly significant; and the coefficients on price declines tend to be positive, but small and statistically insignificant. Moreover, coefficients on oil price increases and oil price decreases are significantly different from each other, indicating that the effect of oil price increases and decreases are indeed asymmetric.

Consistent results are found by Mory (1993) who used a VAR model and showed that the link between increasing prices of oil and GDP in the US economy are asymmetric but declining oil prices of oil do not show substantial favourable effects. Theoretically this may be due to the fact that decreasing oil prices are insignificant in the short run when it comes to benefiting the economy. These results confirm Hamilton's (1996) findings that an inverse correlation exists between oil prices and output as oil prices increase. In other words, they hold in an extensive sample and are supported by the adjustments of price control. Hamilton (1996) introduced an appropriate variable, "net oil prices increase", which confirms the significant inverse link between oil prices and economic growth. This measure differentiates rising oil prices that establish new highs compared to current experiences from increases that simply reverse recent decreases.

Several other studies adopted this measure and conclude that it correctly predicts declines in US real GDP (see Hooker, 2002; Davis and Haltiwanger, 2002; Lee and Ni, 2002). Ali Ahmed and Wadud (2011), for example, estimate the effects of oil price unpredictability on Malaysian macroeconomic performance. The measure of an oil price shock is the Exponential Generalized Autoregressive Conditional Heteroscedastic (EGARCH) model and Hamilton's net oil price increase. To assess the asymmetric effect of oil price shocks on oil price volatility the EGARCH model is used to measure oil price uncertainty. A negative oil price shock has a significant increase on oil price volatility while the positive oil price shock is unable to have a significant effect on oil price volatility. An SVAR model is then used to investigate the effect of oil price uncertainty on Malaysian industrial production, inflation and the treasury bill rate as a proxy for monetary policy response. The SVAR dynamic impulse response functions propose that increasing net oil price result in a significant drop in GDP. The results also show that inflation significantly falls following a one standard deviation shock to oil price uncertainty, and last for a long period of time. This clearly shows that Malaysian monetary authorities adopt a loose monetary policy in reaction to an oil price shock arising from oil price uncertainty. The variance decompositions show that oil price uncertainty accounts for most of the variations in consumer prices and industrial production index after its own shock, which provides evidence that the Malaysian GDP is at risk to oil price shocks regardless of it being a net oil exporting nation. Furthermore, aggregate output significantly decline while consumer prices falls with a positive oil price shock. This results in a negative demand shock due to the postponement of consumption by sectors of the economy. The Malaysian central bank employs an expansionary monetary policy in response to oil price uncertainty. The latest study by Hamilton (2011) reviews the literature on macroeconomic effects of oil price shocks in which nonlinearities still hold while a recent study by Kilian and Vigfusson (2011) shows little verification of the link between prices of oil and US economic activity.

Other studies suggest that the inverse link between oil price shocks and macroeconomic variations is due to the new regime of uncertain oil price changes. Lee and Ratti (1995), for instance, argues that the probability that oil price shocks have a large impact on real GNP is large where prices of oil have been constant compared to where prices of oil have been fluctuating or compared to those that simply correct previous decreases (Hamilton, 2003). The findings suggest that a statistically significant asymmetric effect exists only for positive normalized shocks of oil

prices. These results seem to hold prior to and following 1985 even when other variables are not included.

In order to comprehend the asymmetric relationship between the two variables, various authors consider the co-integration framework. Burbidge and Harrison (1984) employed a bivariate Vector Autoregression (VAR) model and found that oil price shocks granger cause economic variables. Hooker (1996), however, found that there is no causal relationship from oil prices to macroeconomic variables in the US after 1973. In direct response to Hooker (1996), the concept of net oil price increase (NOPI) was initiated by Hamilton (1996). The inclusion of NOPI in a VAR model enabled the US economy to reinstate a significant link between oil prices and output. Lardic and Mignon (2006) examined if whether a long-run relationship does exist between oil prices and output in 12 European nations. From previous empirical literature it is known that the link between oil price shocks and GDP is asymmetric. Therefore, they adopted an Enders and Siklos (2001) approach based on asymmetric co-integration instead of a standard co-integration framework. The results indicate that linear co-integration is not accepted, and that most of the European countries have evidence for asymmetric co-integration between oil prices and GDP.

Empirical evidence of an asymmetric co-integration relationship is less consistent. Cunado and de Gracia (2005) studied the effect of oil price shocks on both output and consumer prices on six Asian nations. They used both international real oil prices and domestic real oil prices for each nation measured in local currency. The impact is higher when the domestic oil price shock is used. There is no co-integrating long run link between oil prices and GDP. This proposes that the effect is only limited to the short run. When analysing the short run relationship between oil prices and output the oil price shock defined in local currencies is found to granger cause output growth rates in Thailand, Japan and South Korea. The effect is significant when oil price shocks are defined in domestic currencies. Furthermore, for the Asian countries the oil price and output link seem to be less significant than the oil price and price level relationship.

Furthermore, Huntington (1998) suggests that a sustained decline in crude oil prices and a sustained rise in oil prices have an asymmetric relationship because of adjustments that are not in the rest of the economy but confined to the energy sector. However, the difference is that the author focuses exclusively on the correlation between GDP and prices of crude oil using an

Ordinary Least Square (OLS) regression model. Real GDP responds asymmetrically to rising crude oil prices and declines but to increasing energy prices or petroleum products the response is symmetric. According to this analysis, it is imperative to comprehend the shocks of oil price effects in the short-run. Accordingly, Hamilton (2003) proposes that shocks of oil prices may only matter in the short-run because there are temporal disruptions of purchasing large investment goods and consumption.

The impact of oil price shocks may differ depending on a country's composition of economic sectors, structures of institutions, energy intensity, the sample period and the development of the economy. Effects of oil price shocks from 1972 to 1988 on US manufacturing jobs (creation and destruction) were investigated by Davis and Haltiwanger (2001) using the sectoral VAR as a model of analysis. The sectoral VAR has sector-specific and common variables. The results show that "increasing oil shock drop the employment rate approximately by 2 percent, which is ten times greater than the projected reaction to a decreasing oil shock of the same size" (Davis and Haltiwanger, 2001:509). Therefore, there is an asymmetric impact of oil price shocks on employment growth and job re-allocation. Employment decline in the short-run is most sensitive to oil shocks compared to job creation for small firms. Similar results are found by Papapetrou (2001) who replaced the industrial production variable with employment to examine the effect of oil prices on employment. Lee and Ni (2002) shows that most industries have the same GDP reaction to oil price shocks. This is because there is a weak relationship between industries' oil intensity and pressure of high oil prices.

The study of asymmetric effects of oil price shocks has been expanded to other nations besides the US. Jimenez-Rodriguez and Sanchez (2005) analyse the effect of oil price shocks on real GDP with a specific focus on eight developed nations (G-7 and Norway). The authors used the multivariate VAR linear and non-linear models. The results from the non-linear model illustrate that increasing oil prices have a greater impact on output than decreasing oil prices. It was found that the effect of declining oil prices on output is statistically insignificant in most cases. Japan, as an oil importing country, experiences a negative impact on GDP when oil prices are rising. In addition, two of the oil exporting countries had different results when faced with increasing oil prices. Norway's GDP has a positive impact from increasing oil prices while the UK had a negative relationship. Norway response shows that it has a large oil producer sector relative to

the economy as a whole (Mork et al, 1994). Another analysis of how consumer prices and industrial production are affected by oil price shocks in 14 European countries using a trivariate VAR model was conducted by Cunado and Perez de Gracia (2003). Their findings show that in the short-run there is an asymmetric effect on GDP growth but a permanent effect on consumer prices by oil prices while in the long-run there is no evidence of such. However, the Euro area has significantly different effects of oil prices on each nation. For instance, Luxembourg's industrial production growth is found to be highly at risk to oil price variations than other nations. Italy's inflation rate also responds differently to the rest of the European Union (EU).

Farzanegan and Markwardt (2009) analyzed the response of macroeconomic variables to oil price shocks, whether asymmetric or symmetric, using a VAR model. The study finds that in Iran, an oil exporting country, the supply side is stimulated by a positive oil price shock, while negative shocks depress output and lowers the real level of imports. Both the increasing and decreasing oil price shocks on the demand side have inflationary effects and raise the overall price level which results in lower real disposable incomes and a decline in demand by consumers. The exchange rate responds positively and increases in the short and medium term to rising oil price shocks. The exchange rate reacts inversely towards decreasing oil prices by enhancing the competitiveness of exports in global markets. This raises the price of exports and the price of imports decline. The positive oil price shocks have visible inflationary consequences once real imports and economic growth increase and real government expenditure also increases in the medium term. Mendoza and Vera (2010) report that in Venezuela, which is an oil exporting country, oil price shocks have asymmetric effects on economic growth. However, in this case an unexpected increase in oil price has a positive significant impact on economic growth.

These results are consistent with studies in other oil exporting developing countries. Eltony and Al-Awadi (2001) estimated a vector autoregression (VAR) model and a vector error correction model (VECM) to investigate the impact of oil price changes on macroeconomic variables for Kuwait economy. The results show causality from oil revenue and oil prices to government recurrent and development expenditure. The empirical evidence reveals that oil price shocks have a large impact on both development and recurrent government expenditure. The impact, however, is observed to be larger on government development expenditure than on government

recurrent expenditure. Both types of government expenditures variations are predominantly attributed to fluctuations in the consumer price index. On the other hand, the variations in imports are largely explained by oil revenue fluctuations followed by fluctuations in government expenditure. Furthermore, they found that in Kuwait oil price shocks have produced a small and modest impact on the demand for money. This can be explained by the well-developed financial sector.

Berument et al, (2010) used a VAR model to analyse the effects of oil price shock in 16 selected Middle East and North Africa (MENA) countries. The results show that oil prices have a positive and statistically significant effect on output growth for net oil exporting nations. The oil price shock is statistically insignificant in other countries. The estimates are further analysed by separating oil supply shocks from oil demand shocks. The overall results show that output increase with positive oil demand shocks but decrease with positive oil supply shocks. When the same procedure is applied to oil exporting countries, GDP growth rises regardless of whether oil price increases are linked to oil supply shocks or oil demand shocks. Hunt (2005) examines the macroeconomic implication of great increases in prices of oil using a variant of the International Monetary Fund (IMF) and Global Economy Model (GEM). In this study, oil is featured as a final consumption good and an intermediate input into production. An inflationary response similar to that of the 1970s is possible due to large oil price increases and real and nominal rigidities arising from costly adjustments. This happens if policymakers have incomplete information on the capacity of supply and the employee's resistance to the loss of their real consumption wages resulting from rising oil prices. However, in the absence of the above responses, the model reflects that oil price shocks will not generate the stagflation witnessed in the 1970s.

However, Olomola and Adejumo's (2006) results are contrary to findings of previous studies. They examine the impact of decreasing and increasing oil prices on GDP growth, monetary supply, real exchange rates and consumer price index (CPI) in Nigeria. They find that output and inflation in Nigeria are not affected by oil price shocks though decreasing and increasing oil prices significantly affect the real exchange rate. They also found that oil price shocks do not affect GDP but rather its manifestation in money supply and real exchange rates. Thus in conclusion oil price shocks are important determinants of real exchange rates and in the long run money supply. This indicates that rising oil prices may increase the wealth effect that strengthens

the real exchange rate. The consequences would be a constraint on a tradable sector resulting in “Dutch Disease”. The Dutch disease seems to be evident due to increasing oil price which increases the real effective exchange rate and strengthens the local currency. The response and timing to a Dutch disease are different for a net oil exporting country. For example, in Iran, this occurs in the medium term (Farzanegan and Markwardt, 2009). However, for the United Kingdom (UK), the response of GDP growth was negative following a positive oil price shock because rising oil prices strengthen the real exchange rate of the local currency. Mork et al, (1994), therefore, state that when oil prices rise, the UK behaves like an oil importing country whereas it is an oil exporting country.

Jimenez-Rodriguez and Sanchez (2005) find that the real effect of oil prices has a parallel framework of impulse response functions. It is detected that a positive oil price shock is negative in the short-run excluding Japan where it is positive. The effect of the shock then diminishes annually, and then erodes out totally. It is further observed that in the US and Canada, the real exchange rate appreciates after an oil price rise. Italy, France also reflect a large negative impact of oil price shocks on their real GDP although the weakening of their exchange rates shows a relatively offsetting role. In Canada, falling oil prices induce a decrease in output growth and strengthening of the exchange rate. This unexpected result has one possible interpretation: the considerable oil price decrease that occurred in the 1980s, after the nation changed from being an importer to an exporter of crude oil. The other variables such as short-term interest rates, long-term interest rates and inflation increase after an oil price shock except for Germany. Concerning the effect of an oil price shock on real wages, a drop is detected in all nations except for Japan and Canada. The effect of decreasing oil prices in net oil exporting countries is larger than the effect of increasing oil prices on the real GDP growth. Furthermore, it is noted that oil price declines lead to a considerable weakening of the exchange rate, reduces both short- and long-run interest rates as well as inflation and increases real wages.

Other studies have extended their analysis to include an investigation of transmission channels of oil price shocks in an asymmetric response to GDP. Huntington (1998) finds that the asymmetry comes from the adjustment costs of oil price changes, crude oil and petroleum product prices. In other words, increasing oil prices affect the economy negatively while decreasing oil prices have

a positive effect, but the cost of regulating to fluctuating oil prices reduce GDP (Hamilton, 1988).

After a rise in oil prices, an asymmetric response is likely to occur because of contractionary monetary policy (Bernanke, Gertler and Watson, 1997; Bohi, 1991). Bernanke et al, (1997) show that a constant federal funds rate and increasing oil price shock accelerates real GDP. However, this is not to say that the response of monetary policy is neutral but it accounts for the fluctuations in GDP growth. Similarly, Brown and Yucel (1999) used a VAR model to dispute previous findings that the reaction of US monetary policy to oil price shocks has been neutral. They base their dispute on the fact that a stable federal funds rate after an oil price shock in a counterfactual experiment shows that both real and nominal GDP and the price level are all higher, which suggests that monetary policy is accommodative in the US. Furthermore, high oil prices show that classic supply side shocks reduce output. Reduction of output is due to increased scarcity of energy that raises oil prices. Consequently, a decline in output growth increases both unemployment and inflation and lowers real wage growth. Consumers are likely to put pressure on real interest rate by smoothing their consumption through borrowing more or saving less if they expect a temporary increase in oil or short-term effects to be larger than long-term effects. Therefore, the demand for real cash balances falls as GDP growth slows down and inflation and real interest rates rise. The reduction in output growth further increases unemployment if wages are nominally sticky downward.

The central bank is accountable for the asymmetric reaction of output subsequent to oil price shocks. Bohi (1991) examined a restrictive monetary policy applied by central banks in four countries (the US, Germany, UK and Japan) and found that the central bank is responsible for the reduction in output following an increase in oil prices. Therefore, he argues that an insignificant relationship exists between the level of oil intensity and oil intensive industries and that there are insignificant effects of oil price shocks on the business cycles of the four countries. Bernanke et al, (1997) confirm this finding using a VAR model. Lee et al, (2001) report that 30-50 percent of the negative effects of oil price shocks are caused by a contractionary policy after an oil price shock in Japan.

These findings are challenged by Hamilton and Herrera (2004) who argue that monetary authorities are partially responsible for minimizing the oil price shock consequences. Hamilton

and Herrera (2004) employed large lag lengths showing that oil price shocks have great direct effects on real GDP. In contrast Tatom (1988) suggests that a stance of monetary authorities account for the disappearance of asymmetric response in US GDP. Leduc and Sill (2004) apply a dynamic general equilibrium model to investigate various monetary policy rules that are used to insulate countries from the consequences of oil price shocks. They found that stabilizing inflation policies lead to improved outcomes for consumer prices and real GDP growth.

Barsky and Kilian (2002) argue that the Federal Reserve should not have allowed the great monetary expansion in the early 1970s because it caused a massive stagflation. This is rejected by Hamilton and Herrera (2004) and Brown and Yucel (1999; 2002) who maintain that counter inflationary monetary policy is partly accountable for the real effects of oil price shocks that hit the US over the past three decades.

Inflationary pressure following increasing oil prices relies on the economy's overall condition for the monetary authorities to react (Bernanke, 2004). For example, if there is an upward pressure on inflation near the upper target and there is an expectation of further increase, then a contractionary monetary policy should be executed. On the other hand, if there is a downward pressure on inflation near the lower target and it is anticipated to be low and constant then the monetary authorities should not interfere with a tighter monetary policy. Sometimes the monetary policy reaction depends on the balance risk of higher inflation or unemployment. An approach that is in between would be for the policy makers to implement nominal income targeting. Consequently, high unemployment would weaken inflationary pressures, and the primary inflationary improvement would prove temporary. A different approach would be to follow policy rules that target unemployment and a suitable measure of inflation (Gramlich, 2004).

Ferderer (1996) proposes an interest rate channel as a possible effect through which oil price shocks respond asymmetrically. He finds that uncertainty and financial stress that are a result of adjusting oil prices negatively strengthen the effects of increasing prices of oil and positively crowd out to some extent the impacts of declining oil prices. The measured impact of oil price changes is sensitive to the type of variable chosen. An example is a nominal oil price variable related to the 1948-1980 time period when rising oil prices resulted in reduced output. Hamilton (1996) formulated another variable termed "net oil price" to differentiate periods of sharply

rising oil prices from normal price instability. A bivariate test was used to examine whether there is a symmetric or asymmetric response of real output and price level to changing oil prices. Two oil price movements were used, namely differenced natural logarithms of oil prices and net oil prices. The results show that the US economic growth responds asymmetrically to oil price changes. Consistent with Hooker (1996), the results show that price of oil adjustment alone has an insignificant impact on economic growth, whereas at a 95 % confidence level, net oil prices alone are significant. It is evident that the asymmetric reaction of real GDP is not constrained to monetary policy.

Brown and Yucel (2002) used a large dimensional VAR model that included a monetary policy response function to investigate the effects of oil price shocks. They found that there is a negative relationship between rising oil prices and economic growth. This asymmetric relationship may be due to monetary policy, shifting demand and adjustment costs. The other channel is the classic supply side effect that is responsible for both retarding economic growth and increasing inflation. The literature suggests that oil price shocks are transmitted through adjustment cost channels and supply effects. Both of these account for slow GDP growth and counter inflationary monetary policy worsen declining GDP. However, Balk et al, (1999) found that it was less likely for sticky nominal wages or monetary policy to have been the cause of the asymmetry; but financial markets are responsible.

Balke et al, (1999) conclude that it is evident that increasing and decreasing oil price shocks have asymmetric effects on GDP and interest rates. In their study, a strong asymmetry found in GDP seems not to hold in the short term because the response of output is negative for both increasing and decreasing oil price shocks. Comparable results for the short run are found by Mork (1994) and Davis and Haltiwanger (2001). The explanation for this behaviour is given by Ferderer (1996). He maintains that oil price shocks result in financial stress, costly adjustment and wages.

The asymmetric reaction to oil price shocks can either be by output or interest rates. Application of the aggregate demand/supply model (AD/AS) by the Federal Reserve (FED) if oil prices rise result in an undesirable reaction policy. The central bank would increase AD and minimize the negative effect on GDP but at a cost of high prices, or decrease AD and minimize the price level at the cost of subdued GDP. On the other hand, aggregate supply may shift further with a rise in oil prices than for an equivalent decline in prices of oil. In the short run an expectation of a

negative response would apply to both increasing and decreasing oil price shocks (Davis and Haltiwanger, 2001). This is consistent with the explanation provided by Ferderer (1996) that oil price shocks lead to financial stress due to either or sticky downward wages and prices. Real GDP responds asymmetrically even though the Federal funds rate is eliminated. Thus, other factors besides monetary policy may be responsible for the asymmetry on the real side. The shift of purchasing power from oil exporting nations to oil importing nations is an avenue used by oil price shocks to affect the economy. This reduces global consumer demand for goods from oil importing countries and the source of savings is increased. The high supply of savings from oil importing consumers trying to smooth their consumption decreases interest rates which can moderately offset upward pressure on interest rates. The decreasing interest rates encourage investment that offsets reductions in consumption and leaves aggregate demand constant in oil importing countries.

Cognigni and Manera (2008) employed an SVAR model for G-7 countries to analyse the effects of oil price shocks on monetary variables and the transmission of monetary policies to the economy. A constant money demand as suggested by the classical theory of money is present in most nations except for the US and Japan, possibly because the co-integrating vector is expected to describe a surplus output link. For the US, Germany, Japan and Canada, real GDP has a large effect on interest rates whereas, inflation rate innovations have a moderate effect. For the US the effects of an oil price shock are due to the monetary policy response function. However, for Italy, France and Canada the impact is offset partially by loosening monetary conditions.

Blanchard and Garli (2007) applied a structural VAR approach to investigate why the effects of oil price shocks have changed overtime. Their statement was based on simulations of a New-Keynesian model. Thus, in the 1970s, high oil prices were related to a high increase in inflation and a sharp decrease in output. In the 2000s, even higher increases in oil prices were related to moderate actions in inflation and output. They argued that the change could be due to the following combination of factors: (1) better monetary policy; (2) lower real wage rigidity; and (3) a smaller share of oil in consumption and production.

The reliability of monetary policy has changed the timing of the reaction of the economy to oil price shocks. In particular, the maintenance of a low and stable inflation rate reflected by the adoption of inflation targeting has improved the policy trade-off that makes it possible to have a

mild impact on positive oil prices both on output and inflation simultaneously. In the 1970s, there was a large stagflation that was generated by real wage rigidities. The smaller impact of the current oil price shocks is due to the trend of more flexible labour markets and flexible wages. Increases in oil prices have encouraged oil price substitution. Accordingly, the consequent decline in output is large enough to have quantitatively significant implications. Blanchard and Riggi (2013) approximate the explanatory power of these factors. They employ a minimum distance estimator that minimizes both samples in pre and post 1984 over a set of structural parameters; the distance between impulse response functions implied by a new Keynesian model; and a structural VAR. The results support the imperative role of these three factors.

### **3.5 Empirical studies on oil price shocks in South Africa**

The discussions in the foregoing section have highlighted the asymmetric link between oil price shocks and macroeconomic variables for oil importing and oil exporting nations. In this section, we review studies that have investigated this relationship in South Africa as a net importer of oil.

The literature on the relationship between oil and inflation in South African have come up with nearly the same results. Swanepoel (2006) adopted a VAR model analysing the impact of three external shocks that included prices of oil on South Africa's different measures of prices (consumer, imports and producer prices). Producer and consumer prices are positive and insignificantly impacted by shocks of oil prices. Swanepoel (2006) concludes that the relationship between inflation and oil price shocks is weak. This weak relationship is induced by the South African Reserve Bank by enforcing policies that help the expectations of inflation to be stabilized in the presence of external shocks such as inflation targeting (Bacilar et al, 2014). The insignificant effect of oil prices on inflation may also be explained by currency movements which cushion the inflationary pressure of high oil prices in South Africa.

Ajimi et al, (2015) explored the relationship between oil price shocks and consumer prices in South Africa, adopting a novel asymmetric causality test from Hatemi (2012). The results show causality running from oil prices to inflation (measured by year-on-year changes in the consumer price index) but it is only observed in the short run since there is no long term co-integrating relationship. The asymmetric test shows that both increasing and decreasing oil prices result in an increasing price level. However, the evidence favours the decreasing oil price shock which

has a stronger effect. On the other hand, Misati et al, (2013) differ from the others by analyzing the transmission of oil price shocks to inflation through the first and second round effects. The study finds that the production of goods and services captures the first round transmission while the second round is captured by inflation expectation of consumers, where the latter relies on monetary policy improvement and labour market flexibility.

Chisadza et al (2013) used a sign restriction-based SVAR model to examine the effect of oil shocks on the South African economy. The study shows that GDP is affected by both oil-specific demand and oil demand shocks driven by international economic activities, while oil supply shocks have an insignificant effect on GDP. These findings take into consideration oil demand shocks, oil supply shocks influenced by oil-specific demand and international economic activity. The oil supply shock is only short lived and impacts the inflation rate significantly with no reaction from monetary policy. This would be contrary to the findings of Swanepoel (2006).

A more specific study was carried out by Aye et al (2014), who used a bivariate GARCH-in-mean-VAR model for investigating how oil price uncertainty impacts manufacturing production in South Africa. The study found that the reaction of manufacturing production to increasing and decreasing oil price shocks is asymmetric. Balcilar et al (2014) examine the effect of an oil price shock on high and low growth regimes of the business cycle in South Africa using a Bayesian Markov switching vector autoregressive (MS-VAR) model. The study finds that it is more likely for high oil price shocks to be in the low growth regime and the impact on GDP growth is also statistically significant. This might be the cause of the asymmetric response of monetary policy to cushion the inflationary pressure from oil price shocks.

The limitations of Swanepoel (2006) and Ajimi et al, (2015) study is that they consider the effect of an oil price shock on inflation prices rather than Real GDP. Even though Bacilar et al, (2014) do consider the latter, their analysis does not include investigating the impact of oil price shocks on monetary policy in South Africa.

### **3.6 Conclusion**

In this chapter, both theoretical and empirical literature on the relationship between oil price shocks, output and monetary policy has been reviewed to understand the symmetric/asymmetric reaction of GDP to oil price shocks and the role of monetary policy. The theory of monetary policy is discussed to explore possible channels that are responsible for the asymmetric relationship between oil price shocks and GDP. The analysis reveals that the interest rate channel, exchange rate channel and money effect channel are possible channels through which oil prices influence output in response to monetary policy. The theoretical literature provides evidence of a possible explanation of the links between monetary policy to oil price shocks. The empirical studies therefore confirm the inverse relationship between oil prices and aggregate economic activities and also the channels that account for this relationship. In the South African context, the asymmetric relationship does also exist.

## CHAPTER FOUR

### METHODOLOGY

#### 4.1 Introduction

This chapter discusses data sources, variable definitions, the methodology and methods of analysing data. The appropriate model that is used is the structural vector autoregressive (SVAR) model. Eviews and Stata computer packages are employed to analyse the data.

#### 4.2 Sources of Data and definition of variables

This study uses monthly time series data from the period 1994:1 to 2013:12. The study period and cut off dates are determined by data availability. The data is obtained from Statistics South Africa, Department of Energy South Africa, South African Reserve Bank's statistical bulletins and various publications of the Federal Reserve Bank. Some of the variables that have been selected are similar to those of Farzanegan and Markwardt (2009) and Jimenez-Rodriguez and Sanchez (2005). This research will use an SVAR model with seven variables, where one of them is characterized as exogenous. In SVAR standards this model is large and any additional variable should make a contribution to output otherwise, the power of the model would decrease.

The variables adopted in the research can be defined as follows:

*Real Gross Domestic Product (GDP)* is a measure of the value of economic output after controlling for price changes. This variable is used to assess the impact of monetary policy and global oil prices on the total output of the economy. The variable is included in the SVAR as a monetary policy goal.

*Exchange rate (EX)* is the value of a nation's currency expressed in another currency. The study uses the value of the South African Rand to a US Dollar as a measure of the exchange rate. A decrease in the exchange rate indicates an appreciation of the Rand and vice versa. South Africa practices a floating exchange rate system.

*Inflation (IF)* is the general price increase of goods and services overtime. The natural log of the consumer price index (CPI) will be used to capture the inflation rate in the economy. According to Bernanke and Blinder (1992), this variable is consistent with the theory that a shock to exchange rate influences inflation in developing countries because of their dependency on imports (cost-push inflation). This variable is entered in the SVAR as a monetary policy goal.

*Interest rate (IR)*: the short-term interest rate used in this study is the average repo rate set by the reserve bank as the monetary policy indicator. This variable in the SVAR is an operating tool of monetary policy.

*Money supply (MS)*: M2 will be used because it is a broad measure of money that includes M1, saving deposit and time deposits (Handa, 2000). Keynesians believe that rising money supply may cause a fall in interest rates and a rise in investment thus leading to an increase in aggregate demand and rising pressure on prices at a given level of output. The variable is considered as an intermediate target of monetary policy.

*Petrol prices*: The oil refineries' biggest input cost is crude oil. Crude oil prices are likely to have a symmetric impact on petrol price. In the SVAR, this variable is expected to put additional pressure, albeit indirectly, on inflationary. South Africa imports about 64% of crude oil (Department of Energy South Africa, 2015).

*Crude oil prices (OP)*: is an exogenous variable that measures external shocks on the economy.

### **4.3 Research techniques**

Since Sims (1980), vector autoregressive models (VARs) and structural VARs have been the benchmark for econometric modeling of monetary policy transmissions. When comparing an SVAR to a VAR, the SVAR is deemed more suitable for examining the non-contemporaneous response of economic variables to monetary variables while, the reverse is permitted by the monetary authorities through imposing restrictions on the monetary block (Favero, 2001). The above is based on a non-recursive assumption which states that structural disturbances are orthogonal. Despite the fact that SVARs cannot perform dynamic simultaneous equations, they have an added advantage of avoiding the difficulties that characterize the traditional approach and make the approach simple by using structural analyses. SVARs are also more preferable to

the VAR because they use economic theory to classify the simultaneous relationships among variables (Bernanke, 1986).

This research will apply an SVAR model because of its attractive features. For instance, the SVAR is able to review empirical relationships without placing too many restrictions on data and is accountable for endogenous relationships (Berkelmans, 2005). The SVAR can be used to assess the effect of monetary policy innovations, since policy innovations, structural shocks and their transmission are driving macroeconomic adjustment in the model. This approach does not require a structural model for the mechanisms of monetary policy design, transmission and describing the economy (Van Aarle et al, 2003). Therefore, the model minimizes the number of restrictions and also, has variance decompositions and impulse response functions which provide information on policy innovations and the impact and transmission of monetary shocks. Furthermore, the SVAR has the flexibility and ability to accommodate a variety of macroeconomic variable relationships (Raghavan and Silvapulle, 2008).

It is a common practice in time series literature to transform non-stationarity data through differencing. However, this study uses an SVAR in levels, consistent with most of the literature used in this study (see Sims et al, 1990; Dungey and Pagan, 2000; Berklemans, 2005). Variance decomposition and impulse response functions are used to examine the spillover effects of all the variables in the model. According to Ramaswamy and Sloek (1998), level SVAR impulse response functions permit time and history to determine whether the impact of a shock is permanent or not unlike the VECM or differenced SVAR which concludes that shocks are permanent. The advantage of the SVARs in levels is that they have a low computation burden and suitable for the test hypothesis on the channels of monetary policy due to the exogeneity of the monetary policy shocks.

#### **4.4 SVAR framework**

The SVAR model for this study consist of seven variables namely, petrol prices in South Africa (PE), interest rate (IN), real output (GDP), money supply (MS), inflation CPI (IF), exchange rate (EX) and crude oil prices (OP). Crude oil price is an exogenous variable that represents an external shock to the South African economy. Output and inflation are used in the SVAR as

policy goals; money supply and exchange rates are intermediate targets of monetary policy; and the interest rate is an operating tool of monetary policy.

Real GDP unlike the other variables is a direct linkage through which positive or negative oil prices affect the economy through policy changes; while petrol prices have an indirect effect since they capture the input cost of production (Peersman and Van Robays, 2009). Except for interest rates, all variables are measured in natural logarithms. Real GDP and inflation are seasonally adjusted in order to remove cyclical seasonal movements that are common in monthly time series data.

Assume that monetary policy and asymmetric effects of oil price shocks in South Africa are described by the following structural form equation.

$$Ky_t = \varphi + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \dots + \beta_p y_{t-p} + \Phi_i u_t + X \varepsilon_t \quad \text{eq1}$$

The description of contemporaneous relationships among the variables is denoted by  $K$ , an invertible ( $m \times m$ ) matrix;  $y_t = y_{1t}, y_{2t}, \dots, y_{nt}$  is an ( $m \times 1$ ) vector of endogenous variables;  $\varphi$  is an ( $m \times 1$ ) vector of constants;  $\beta_i$  is a ( $m \times m$ ) matrix of coefficient of lagged endogenous variables (*for all*  $i = 1, 2, \dots, p$ );  $\Phi_i$  is an ( $m \times 1$ ) vector of coefficients for the exogenous variable; and  $u_t$  is the exogenous variable that captures external shocks;  $X$  is a ( $m \times m$ ) matrix which allows for direct effects of some shocks on more than one endogenous variable in the system because of its non-zero off diagonal elements; and  $\varepsilon_t \sim \text{NIID}(0, \sigma^2)$  is a white noise structural disturbance term.

Equation 1 presents an SVAR that is estimated indirectly because of the contemporaneous feedback inherent in a VAR process (Enders, 2004). The process described in equation 1 has feedback due to endogenous variables that affect each other in current and lagged values of  $y_t$ . Therefore, the parameters are unidentified and it is impossible to uniquely determine their values (McCoy, 1997). However, the information in the system can be recovered by estimating a reduced form VAR implicit in equation 1. This can be done by pre-multiplying equation 1 by an inverse of  $K$  (see Ngalawa and Viegi, 2011).

$$Y_t = K^{-1}\varphi + K^{-1}\sum_{i=1}^p \beta_i y_{t-i} + K^{-1}\Phi_i u_t + K^{-1}X \varepsilon_t \quad \text{eq2}$$

Defining  $K^{-1}\phi = \Psi$ ,  $K^{-1}\beta_i = \psi_i$ ,  $K^{-1}\phi_i = \delta_i$  and  $K^{-1}X\varepsilon_t = \alpha_i$  (for all  $i = 1, 2, 3, \dots, p$ ), we can rewrite equation 2 in standard matrix form as:

$$Y_t = \Psi + \sum_{i=1}^p \psi_i y_{t-i} + \delta_i u_t + \alpha_i \quad \text{eq3}$$

In equation 1, all variables have contemporaneous effects on each other. This is called a structural VAR or primitive system. In equation 3, the right hand side variables are predetermined at time  $t$  and no variable has a direct immediate effect on another in the model. This is a reduced form VAR. The residual  $\alpha_i$  is a composite of shocks in  $Y_t$  (Enders, 2004). Given the estimated reduced form VAR in equation 3, restrictions are imposed on the coefficients of matrices  $K$  and  $X$  so that the structural shocks are separated from the estimated reduced form residuals:

$$K\alpha_i = X\varepsilon_t \quad \text{eq4}$$

Suppose that the orthogonal structural innovation is  $E(\alpha_i, \alpha_i') = 1$ , and  $\Sigma = E(\varepsilon_t, \varepsilon_t')$  is the constant variance-covariance matrix of the reduced form equation residuals, which impose identifying restrictions on  $K$  and  $X$  as indicated in equation 5:

$$K\Sigma K' = XX' \quad \text{eq5}$$

Both matrices  $K$  and  $X$  are  $(m \times m)$  which sum up to  $2m^2$  unknown elements upon which  $\frac{m(m+1)}{2}$  restrictions are imposed by equation 5. This means  $2m^2 - \frac{m(m+1)}{2}$  or  $\frac{m(3m+1)}{2}$  additional restrictions are required for the identification of  $K$  and  $X$ . There are many ways in which these restrictions can be imposed. For instance, Sims (1980) suggest recursive factorisation based on Cholesky decomposition of matrix  $K$ . Studies that use this restriction tend to be controversial according to Christiano *et al*, (1998). The application of these restrictions according to Favero (2001) is that the structural shocks depend on the ordering of the variables, the last one being the most endogenous variable and the first one being the most exogenous. Thus, changing the ordering of the variables changes the VAR equations, error terms, and parameters and there are  $m!$  recursive VARs, showing every possible ordering. Furthermore, Cholesky factorisation is not valid when a simultaneity problem exists between monetary variables. Due to its drawbacks,

several authors have adopted other identifications of the structural shocks (Sims, 1986; Bernanke and Mihov, 1998).

Structural factorization imposes restrictions on the elements of matrices K and X based on economic theory (Sims, 1986; Sims and Zha, 2006). This research employs the same approach. Based on the assumption that structural disturbances are orthogonal the structural model is identified by “imposing that monetary variables instantaneously react to macroeconomic variables, while the instantaneous feedback is not permitted, and imposing restrictions on the monetary block of the model reflecting the operational procedures applied by the monetary authorities” (Favero, 2001:166). The following scheme identifies the structural shocks of equation 4 (see Ngalawa and Viegi, 2011)

$$K = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ k_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ k_{31} & k_{32} & 1 & k_{34} & k_{35} & k_{36} & k_{37} \\ k_{41} & k_{42} & 0 & 1 & 0 & 0 & 0 \\ k_{51} & k_{52} & 0 & 0 & 1 & k_{56} & 0 \\ 0 & 0 & 0 & k_{64} & 0 & 1 & 0 \\ 0 & 0 & k_{73} & k_{74} & k_{75} & k_{76} & 1 \end{bmatrix} \quad \alpha_i = \begin{bmatrix} \alpha_i^{logOP} \\ \alpha_i^{logPE} \\ \alpha_i^{logEX} \\ \alpha_i^{logIF} \\ \alpha_i^{logMS} \\ \alpha_i^{logGDP} \\ \alpha_i^{IN} \end{bmatrix}$$

$$X = \begin{bmatrix} x_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & x_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & x_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & x_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & x_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & x_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & x_{77} \end{bmatrix} \quad \varepsilon_i = \begin{bmatrix} \varepsilon_i^{logOP} \\ \varepsilon_i^{logPE} \\ \varepsilon_i^{logEX} \\ \varepsilon_i^{logIF} \\ \varepsilon_i^{logMS} \\ \varepsilon_i^{logGDP} \\ \varepsilon_i^{IN} \end{bmatrix}$$

The above identification scheme shows how the variables influence each other depending on their position. Both matrices K and X have non-zero coefficients  $k_{ij}$  and  $x_{ij}$ , indicating that any residual  $j$  affects variable  $i$  instantaneously. Equation 1 represents crude oil prices responding to their own lagged values while equation 2 shows that petrol prices respond contemporaneously to crude oil prices. Both variables indicate that their reactions are sluggish when responding to monetary variable shocks because of planning and information delays (Sims and Zha, 1998; Karame and Olmedo, 2002; Berklemans, 2005). The third equation shows that the exchange rate

responds contemporaneously to all the variables. This equation shows that the exchange rate has a contemporaneous effect on all variables because exchange rates are forward-looking asset prices (Kim and Roubini, 2000).

Inflation in the fourth equation responds contemporaneously to crude oil prices and petrol prices. Economic theory hypothesizes that an increase in output would also increase inflation. Output has an instantaneous effect on inflation only. The interest rate has a contemporaneous effect on exchange rates, money supply, output and inflation.

#### 4.5 Test for asymmetric effects

This study follows the Morks (1989) specification in the investigation of crude oil prices on Real GDP, petrol prices and monetary variables. In this specification, oil prices are distinguished between monthly increasing crude oil price changes and decreasing crude oil price changes, as follows:

$$\Phi_i u_t^+ = \begin{cases} \Delta \Phi_i u_t & \text{if } \Phi_i u_t \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\Phi_i u_t^- = \begin{cases} \Delta \Phi_i u_t & \text{if } \Phi_i u_t < 0 \\ 0 & \text{otherwise} \end{cases}$$

where  $\Phi_i u_t$  indicates the coefficient and vector of the exogenous variable which is the global oil price. Recall equation 1:

$$Ky_t = \varphi + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \dots + \beta_p y_{t-p} + \Phi_i u_t + X \varepsilon_t \quad \text{eq1}$$

The starting point would be to decompose  $\Phi_i u_t$  into its positive and negative rate of change in global oil price as defined by the above specification. The application of the above definition to equation 1 is as follows:

$$Ky_t = \varphi + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \dots + \beta_p y_{t-p} + \Phi_i u_t^+ + X \varepsilon_t \quad \text{eq6}$$

$$Ky_t = \varphi + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \dots + \beta_p y_{t-p} + \Phi_i u_t^- + X \varepsilon_t \quad \text{eq7}$$

In this study, the SVAR will analyse the reaction of monetary variables to oil price shocks and also the direct impact of this external shocks. This analysis will make use of Mork's (1989) asymmetric definition of crude oil price changes in equations 6 and 7.

## **4.6 Estimation of Results**

### **4.6.1 Lag length**

In order to choose an appropriate lag length for the SVAR model the Akaike Information Criterion (AIC) is employed. This is necessary for the selection of an autoregressive truncation lag ( $j$ ). This requirement forms the analysis for the SVAR estimation in analyzing the variance decomposition and impulse response functions. According to Ng and Perron (1995) and Lopez (1997), assumptions have continuously revealed a strong relationship between  $j$  and the extent of power loss. Therefore, research has indicated that there is no working procedure for selecting the lag length  $j$  that yields satisfactory and robust results. Hence, the model chosen is the one with the lowest value of information criteria test. However, Ng and Perron (2001) highlight that it depends on the size of  $j$ . If  $j$  is small, then it is suitable for finite order autoregressive error processes with small moving average components; and a large  $j$  is adequate for noise functions with a moving average root that is large.

### **4.6.2 The variance decomposition**

Variance decomposition provides the percentage of the fluctuations in the explained variables that are due to their own innovations, versus shocks to the other variables (Brooks, 2002).

### **4.6.3 The impulse response functions**

This is when a dynamic system responds to an external shock. Within the VAR framework, "the impulse response function traces out the anticipated reactions present and forthcoming values of each of the variables to a shock in one of the VAR equations" (Gujarati, 2004: 849). For this study, the impulse response function will interpret the effects of oil price shocks on inflation, real

GDP, monetary variables and cumulative impulse response functions so as to explain the overall effects of the shocks upon dependent variables in a given period.

#### **4.7 Conclusion**

The chapter provides a detailed discussion of the econometric techniques that are used to investigate the statistical properties of the data as well as the SVAR model. Mork's (1989) specification was used for the asymmetric effects of oil price shocks which were then incorporated into the model. The results will be analysed using impulse response functions and variance decompositions which are also explained in this chapter.

## CHAPTER FIVE

### EMPIRICAL FINDINGS

#### 5.1 Introduction

This chapter presents and discusses empirical results obtained from a structural vector autoregressive (SVAR) model. This analysis includes choosing an appropriate lag length, analyzing the impulse response functions and variance decompositions and providing an economic interpretation of the econometrics results. The results obtained from these procedures are derived from the levels specification of the SVAR. This methodology will enable one to answer the research questions. It will also serve as a guideline for possible policy recommendations.

#### 5.2 Estimation and results

##### 5.2.1 Lag length test

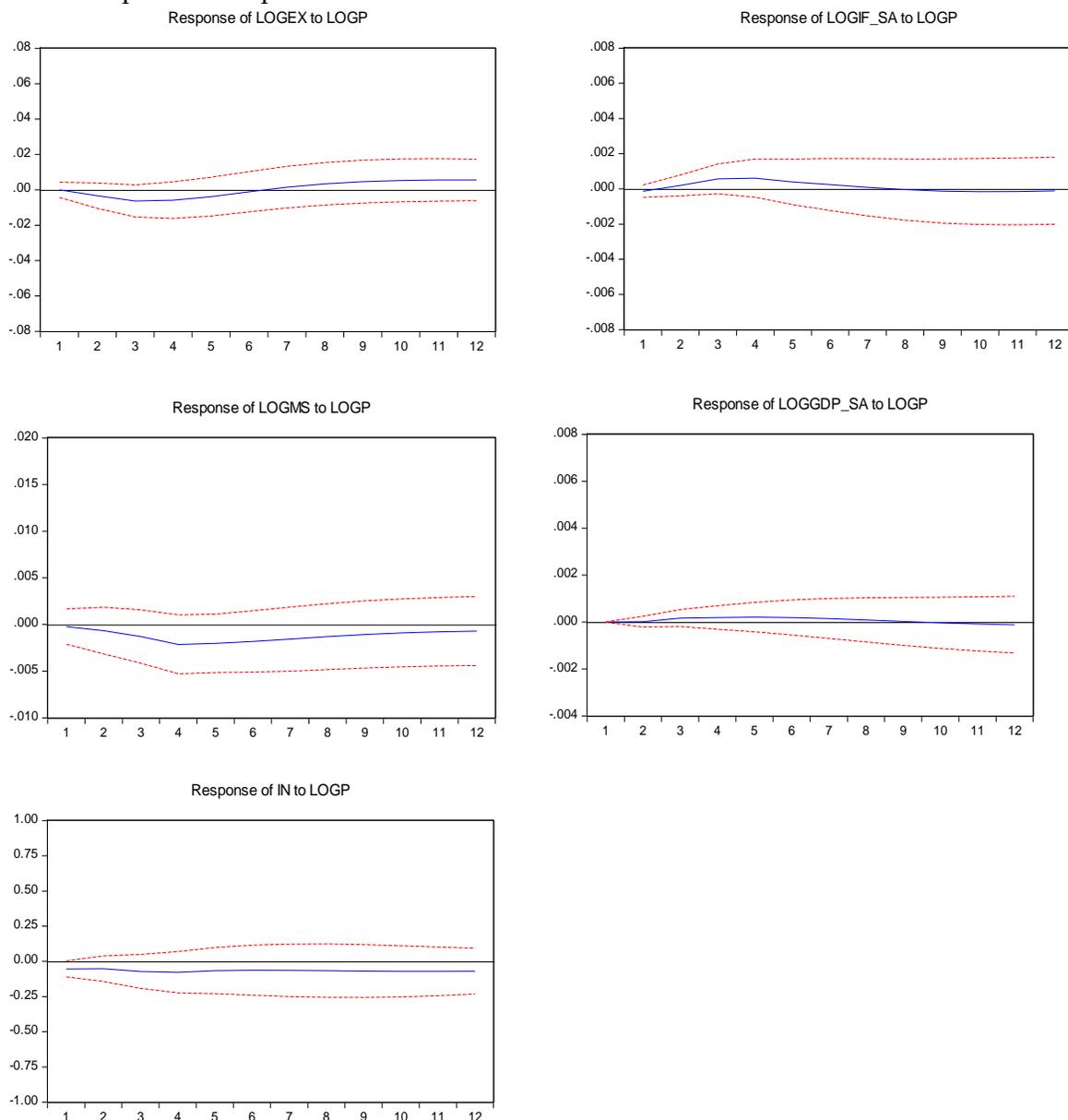
There are various lag selection criteria, but this study uses the Akaike information criterion (AIC). The AIC is used because it minimizes the chance of underestimation while maximizing the chance of recovering the true lag length and is of popular use in the literature (Gujarati, 2004). It also gives the minimum number among the lag lengths. This criterion established that the optimal lag length is three for equation 6 and two for equation 7.

##### 5.2.2 The response of Monetary variables to asymmetric shocks in oil prices

Figure 2 presents impulse responses of the exchange rate, inflation, money supply, real GDP and interest rates to a positive oil price shock. The figure shows that increasing oil prices appreciate the exchange rate bottoming out at 3 months and then depreciates peaking at 9 months. This response, however, is insignificant. The appreciation of the Rand following a rise in oil price strengthens the short term capital account of the balance of payment. This is in line with the economic theory that there will be short-term capital inflows due to the income transfers from an oil exporting country to an oil importing country. Consequently, the currency appreciates.

However, the appreciation of the currency is relatively small, meaning that international capital flows are less responsive to domestic interest rates. As the country is importing oil, the money supply goes up (Barro, 1978). The rise in money supply in turn drives up the prices of South Africa's products as stated by the quantity theory of money. Domestically produced goods become less competitive globally so that the country's exports decrease and imports increase. As a result, the domestic currency depreciates.

Figure 2: Impulse responses of the exchange rate, inflation, money supply, real GDP and interest rates to a positive oil price shock



The figure also shows that the price level (inflation) responds positively to increasing oil prices peaking at 3 months, and thereafter declines, returning to equilibrium by about the 9<sup>th</sup> month. The response, however, is insignificant. The positive response may be expected because increasing oil prices fuel inflation in South Africa. The impact of oil prices on inflation depends on how domestic oil prices move with international prices. In South Africa, an import parity pricing formula is used which rely on the global spot price of refined oil which is known as the basic fuel price (SAPIA, 2006). The marginal effect might be explained by oil prices having a smaller effect on consumer prices compared to production prices because imports have a weight of 27 percent in the producer price index, in contrast to an approximately 6 percent weight in the general consumer price index excluding interest rates on mortgage bonds (see Swanepoel, 2006). Moreover, increasing oil prices have a larger effect on producer prices than on consumption prices as both downstream petrol prices and crude oil prices are included in the production price index. Inflation and oil price shocks are weakly associated (see Bacilar et al, 2014). This might be due to currency movements, which cushioned the inflationary impact of higher oil prices in South Africa (Swanepoel, 2006). The rising oil prices will increase inflation and widen current account deficits in the short run. The impact of oil prices reflects the importance of oil in the representative consumer basket and the exchange rates. There have been improvements in monetary policy frameworks that resulted in better anchoring of long-run inflation expectations (Cunado and Gracia, 2005; Cologni and Manera, 2008).

It is further observed in figure 2 that high oil prices cause the money supply to decrease and bottom out at about 4 months before gradually rising back to equilibrium. This response represents monetary tightening so as to cushion inflationary pressure. In this case consumers are more likely to be in debt resulting in a fall in real balances and a further rise in the price level (Cologni and Manera, 2008). The negative response of money supply is in line with economic theory which states that a rising oil prices is anticipated to cause the domestic price level to rise because petroleum products would rise. A higher oil price level would cause the money supply to decline, leading to less consumption spending and lower real output. The response is, nonetheless, insignificant.

The figure also shows that increasing oil prices marginally raise real GDP, peaking after 3 months and thereafter declining to equilibrium after about 11 months. The response is insignificant. The output reaction is very sluggish when oil prices are rising because they have the potential to slow GDP growth. A possible explanation is that given the small share of domestic oil production, the influence of a positive oil price shock is expected to be relatively small. The declining impact of oil price shocks on output may be due to structural changes such as falling oil-intensity and flexible labour markets (Blanchard and Gali, 2007). Wakeford (2013) reports that in 1994 petroleum dependency increased by 5.4 percent, after which it dropped monotonically by an average of 2 percent per annum, an accumulative 20 percentage points by 2009. Another possible explanation, in the long run, is that high oil costs may cause industries to decrease their investment in new capital hence, the reduction in output. High oil prices may not significantly impact the South African economy. The abundance of coal and well advanced synthetic fuel industry serves as a substitute source mitigating the economy from the volatile global oil prices (Fofana et al,2009).

Finally, the figure also reveals that positive oil prices decrease interest rates, albeit insignificantly. The central bank might decrease interest rates (representing a monetary expansion) which could lead to an increase in investment, and hence an increase in output. With lower interest rates, we expect capital outflow and a fall of the local currency. The weak domestic currency will increase net exports which in turn stimulates national income. On the demand side, the increase of oil prices put pressure on the price level (Balcilar et al, 2014). Investors borrow for production (Aye et al, 2014) hence, for them to increase their borrowing, interest rates should be adjusted downwards. The monetary authorities might be trying to avoid large economic downturns by decreasing interest after an oil price shock. In this case, a positive oil price shock leads to a decrease in interest rates and a rise in real GDP (Bernanke et al, 1997).

The increase in oil prices raises input cost of production and thus reduces production. Therefore, insignificant interest rate response can be interpreted as an outcome of the monetary authorities attempting to keep the interest rate constant so as to mitigate output declines, at least in the short run (Apergis, 2014). Furthermore, the adoption of inflation targeting promotes price stability (Cognigni and Manera, 2008). Thus, despite the upward pressure on inflation, the reserve bank has little stimulus to increase interest rates. Moreover, countries that have adopted the inflation

targeting framework are less susceptible to oil price shocks (Mishkin, 2007). This illustrates relative resource decoupling that can be partly explained by the growth in the financial service sector which has low oil intensity (Wakeford, 2013). Therefore, future oil imports will be reduced while attenuating low real GDP.

Figure 3 presents impulse responses of exchange rates, inflation, money supply, real GDP and interest rates to a negative oil price shock. The figure shows that the exchange rate appreciates bottoming out at 3 months, and then depreciates peaking at 9 months, in response to decreasing oil prices. However, the response is marginal and insignificant. The impact of low oil prices on exchange rates depend on expectations about capital flows, trade balances and speculation. South Africa has a current account deficit of 5.8 percent of GDP, largely because income is being transferred from the country as a net oil importer to oil exporting countries (see National Treasury, 2015). A tightening monetary policy in the country leads to a rise in domestic interest rates, which in turn encourages short-term capital inflows. The decrease in domestic income appreciates the domestic currency. The appreciation of the local currency then makes home goods relatively less competitive on the international market. Therefore, a decrease of oil imports is balanced by a decrease in exports or a decrease in other imports in a resource constrained economy thereby weakening the exchange rate (Fofana et al, 2009). The weaker rand raises import cost, further imposing a negative effect on output.

Figure 3: Impulse responses of exchange rates, inflation, money supply, real GDP and interest rates to a negative oil price shock

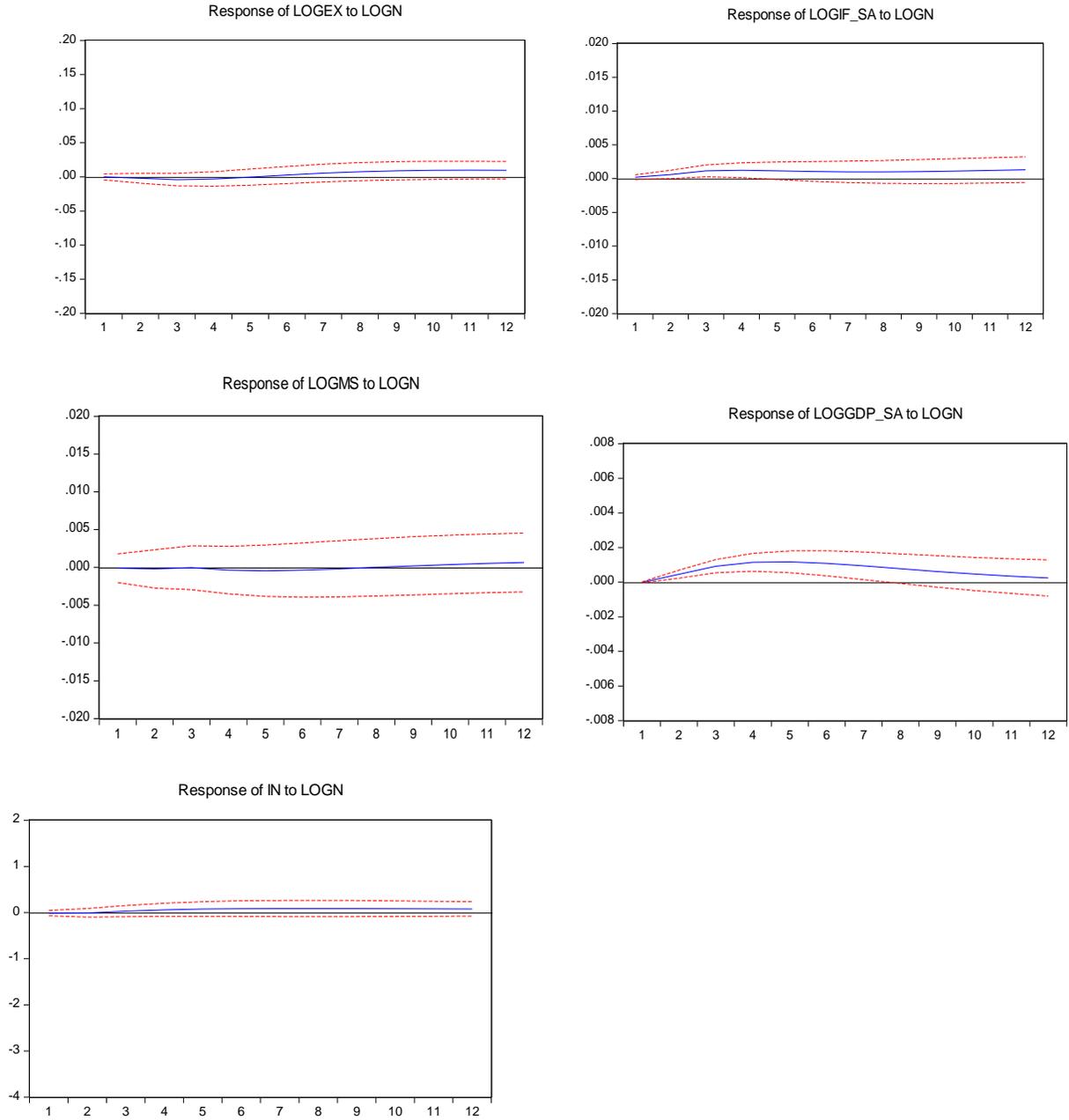


Figure 3 also shows that decreasing oil prices cause inflation to increase significantly within the first 4 months and thereafter the response remains persistent and insignificant. This is a surprising result. Normally, one would expect a decline in oil prices to put downward pressure

on the cost of production consequently leading to a fall in the general price level. However, this assumes that the exchange rate remains stable. If the domestic currency is depreciating, the local currency cost of oil for a net importer is expected to go up, in the process leading to an increase in inflation. However, Figure 3 shows that while the local currency indeed depreciates, the response is insignificant and occurs with a five-month lag. It is further observed in the figure that output increases significantly following the negative oil price shock. While the lower oil costs reduce the cost of production, leading to a higher output, other factors of production can only be employed at a higher cost, assuming the economy is initially in equilibrium. If the higher cost of the other factors of production outweighs the lower oil prices, the total cost of production will be higher in the wake of lower oil prices and higher output, causing an increase in inflation.

It is further observed in figure 3 that money supply does not respond to a negative oil price shock until after 3 months where it declines slightly and bottoms out at about 4 months, before it rises marginally, peaking at about 11 months. The responses are, nonetheless, insignificant. This might be due to the monetary authority's inability to meet the growing demand for money due to their commitment to keeping inflation within a 3 – 6 percent band. The marginal increase of money supply that follows declining oil prices may be explained by the shift of purchasing power from oil exporting countries to the domestic economy as a net oil importer.

The figure reveals that real GDP responds positively and significantly to decreasing oil prices peaking at about 6 months then gradually falling to equilibrium. The response is only significant for the first 7 months. Lower oil prices reduce the input cost of production and, therefore, increasing production in a country. Policies that reduce oil price shocks are likely to contribute to the increase in real GDP. This is because the policy may favour lower import bills and increase expansion in exports through the weak exchange rate. Moreover, these policies will keep interest rates at a minimal level that will encourage investment (Fofana et al, 2009). The lower cost of production translates into higher investment. On the demand side, a fall in oil prices raises consumers' real income and leads to an increase in consumption (Hamilton, 2009; Kilian, 2014).

Figure 3 demonstrates that interest rates do not respond to decreasing oil prices until after 4 months when it starts increasing marginally. However, this response is not statistically significant. The marginal increase in interest rates may be attributed to the fact that declining oil prices are observed to be inflationary.

As discussed in the literature, several studies have found an asymmetric relationship between oil prices and GDP growth (see, for example, Mork, 1989; Mory, 1993; Olsen and Mysisen, 1994; Hamilton, 1996; Cunado and Perez de Gracia, 2003; Hamilton, 2003; Jimenez-Rodriguez and Sanchez, 2005; Mork and Killian, 2005; Huang et al, 2005). However, their explanation for this asymmetric relationship is contrary to this study's findings because they suggest that rising oil prices reduce GDP, but declining oil prices fail to stimulate it. The findings of this study suggest that South Africa has an asymmetric relationship based on the fact that increasing oil prices fail to stimulate output while decreasing oil prices increase output significantly. Furthermore, the asymmetric relationship is also evident on interest rates, money supply and inflation. The exchange rate variable sheds some light on the oil price puzzle. This can be noted by the reaction of the exchange rate changes to decreasing oil prices, which closely resemble those for increasing oil prices. This proposes that dropping oil prices are followed by expansionary monetary policy and that the degree of the policy reaction is similar to that detected for rising oil price (Federer, 1996). This shows that there is a slight asymmetric policy response between real exchange rates and oil price shocks.

### **5.3 Variance decomposition of asymmetric oil price shocks**

To understand the real effects of monetary policy, the study further investigates the contribution of operating tools of monetary policy to intermediate monetary policy targets with Real GDP and inflation as monetary policy goals in a given state of the economy.

Table 1 presents the contributions of all variables in the model to variations in one of the monetary policy goals, the rate of inflation, when crude oil prices are increasing (Table 1(a)) and when they are decreasing (Table 1(b)). Table 1(a) shows that when oil prices are increasing, less than 1 percent of variations in the rate of inflation are explained by fluctuations in crude oil prices after a year (0.9 percent after three months; 0.69 percent after six months; 0.38 percent after nine months and 0.28 percent after a year). However, when crude oil prices are decreasing (see Table 1(b)), a larger proportion of inflation variations are explained by changes in crude oil prices (3.60 percent after three months; 3.89 percent after six months; 3.32 percent after nine months and 3.40 percent after a year), underscoring the asymmetric response of inflation to crude oil price fluctuations.

Table 1

(a) *Variance decomposition inflation when oil prices are increasing*

Months	SE	Crude oil price	Petrol price	Exchange rate	Inflation	Money supply	Real GDP	Interest rate
3	0.006495	0.901404	0.827834	14.85490	72.57694	0.229939	1.896298	8.712685
6	0.011872	0.686236	0.643795	21.97098	56.26953	1.133568	2.249102	17.04679
9	0.016129	0.381377	0.891244	23.06834	48.01105	2.147508	1.761223	23.73926
12	0.019379	0.279725	0.782591	22.26072	42.59959	3.080543	1.264827	29.73201

(b) *Variance decomposition inflation when oil prices are decreasing*

Months	SE	Crude oil price	Petrol price	Exchange rate	Inflation	Money supply	Real GDP	Interest rate
3	0.006885	3.595618	0.312820	15.03433	74.16311	0.070083	2.239569	4.584476
6	0.012003	3.891175	0.689013	22.65862	58.05660	0.550623	1.268640	12.88533
9	0.016054	3.324697	0.793903	24.19043	48.90823	1.164351	0.777883	20.84050
12	0.019489	3.402367	0.631527	23.74937	42.21940	1.665051	0.922570	27.40972

Table 1 also reveals that monetary policy is asymmetric in its response to crude oil changes. When crude oil prices are increasing, interest rate adjustments (the primary operating tool of monetary policy in South Africa) account for a larger proportion of fluctuations in the rate of inflation (see Table 1 (a)) than when crude oil prices are decreasing (see Table 1(b)). Interest rate variations explain 8.71 percent, 17.05 percent, 23.74 percent and 29.73 percent of inflation fluctuations after three, six, nine and twelve months, respectively, when crude oil prices are increasing; and 4.58 percent, 12.89 percent, 20.84 percent and 27.41 percent of inflation fluctuations after three, six, nine and twelve months, in that order, when crude oil prices are decreasing. This indicates that monetary authorities do not respond symmetrically to crude oil price changes.

Besides own fluctuations and interest rate changes, it is observed in Table 1 that exchange rate variations account for a very large proportion of the fluctuations in inflation rates. Exchange rate variations account for 14.85 percent, 21.97 percent, 23.07 percent and 22.26 percent of the fluctuations in inflation rates after three, six, nine and twelve months, respectively, when crude oil prices are increasing; and 15.03 percent, 22.66 percent, 24.19 percent and 23.75 percent of

the fluctuations in inflation rates when crude oil prices are decreasing. This reveals that the exchange rate channel is important in the transmission of monetary policy in South Africa. In addition, it is observed that the role of the exchange rate in the transmission process of monetary policy is also asymmetric. Table 1 shows that the exchange rate movements account for a larger proportion of the fluctuations in inflation rates when crude oil prices are decreasing than when they are increasing.

Table 2 presents the variance decomposition of the second monetary policy goal, real GDP, when oil prices are increasing (Table 2(a)) and when they are decreasing (Table 2(b)). Consistent with the impulse response analysis, Table 2(a) shows that when oil prices are increasing, crude oil prices account for a very small proportion (less than 1 percent) of the variations in GDP (0.20 percent, 0.30 percent, 0.18 percent and 0.13 percent after 3, 6, 9 and 12 months, respectively) whereas when oil prices are decreasing, crude oil prices account for a relatively large proportion of the fluctuations in GDP (6.86 percent, 11.14 percent, 8.60 percent and 5.94 percent after 3, 6, 9 and 12 months, in that order).

Table 2

*(a) Variance decomposition of real GDP when oil prices are increasing*

Months	SE	Crude oil price	Petrol price	Exchange rate	inflation	Money supply	Real GDP	Interest rate
3	0.003814	0.195519	0.690184	0.031360	0.426854	1.766521	96.80279	0.086775
6	0.006978	0.299564	0.302443	0.505517	0.559508	3.633501	94.32130	0.378172
9	0.009854	0.181670	0.883868	3.137419	0.346883	5.442558	88.88537	1.122228
12	0.012562	0.125232	1.526585	7.587397	0.325985	7.251961	80.98340	2.199440

*(b) Variance decomposition of real GDP when oil prices are decreasing*

Months	SE	Crude oil price	Petrol price	Exchange rate	inflation	Money supply	Real GDP	Interest rate
3	0.003948	6.858854	0.048492	0.076395	0.915768	1.699169	90.05322	0.348101
6	0.006672	11.14243	0.977220	0.704646	1.501196	4.409886	81.03854	0.226081
9	0.008913	8.601119	2.361354	4.587404	2.548759	7.107090	74.50575	0.288523
12	0.011030	5.944862	3.161479	10.51936	3.679153	9.585973	66.27308	0.836089

Table 2 also reveals that the contribution of interest rate changes to real GDP variations is larger when crude oil prices are increasing than when they are decreasing, providing further evidence of asymmetric monetary policy response to crude oil price changes; and asymmetric response of real GDP to crude oil price changes. Table 2(a) shows that after 3, 6, 9 and 12 months, interest rates account for 0.09 percent, 0.38 percent, 1.12 percent and 2.2 percent of the variations in real GDP, in that order, when crude oil prices are increasing; and Table 2(b) reveals that after 3, 6, 9 and 12 months, interest rates account for 0.35 percent, 0.23 percent, 0.29 percent and 0.84 percent of the real GDP fluctuations, respectively, when crude oil prices are decreasing.

Table 2 also shows that money supply accounts for a larger proportion of the fluctuations in real GDP than exchange rates, indicating that money supply may be a more important intermediate target of monetary policy than exchange rates in the transmission of monetary policy where the policy goal is real GDP. Table 2(a) shows that after 3, 6, 9 and 12 months, exchange rates account for 0.03 percent, 0.51 percent, 3.13 percent and 7.59 percent while money supply accounts for 1.77 percent, 3.63 percent, 5.44 percent and 7.25 percent, respectively, of the fluctuations in real GDP. Table 2(b) on the other hand, reveals that after 3, 6, 9 and 12 months, exchange rates account for 0.08 percent, 0.70 percent, 4.59 percent and 10.52 percent while money supply accounts for 1.70 percent, 4.41 percent, 7.11 percent and 9.59 percent, in that order, of the fluctuations in real GDP.

Table 3 presents the variance decomposition of money supply, an intermediate target of monetary policy. The table reveals that exchange rate movements account for less than 1 percent of the fluctuations in money supply in any period up to a year, whether crude oil prices are increasing or decreasing. Interest rates, on the other hand, account for a relatively larger proportion of the fluctuations in money supply estimated at 2.04 percent, 3.15 percent, 3.86 percent and 4.31 percent after 3, 6, 9 and 12 months, respectively, when crude oil prices are increasing (see Table 3(a)); and 2.14 percent, 5.12 percent, 7.48 percent and 9.17 percent after 3, 6, 9 and 12 months, in that order, when crude oil prices are decreasing (see Table 3(b)). These figures show that the contribution of interest rate changes to money supply fluctuations is larger when oil prices are decreasing than when they are increasing, which corroborates the earlier findings of asymmetric monetary policy responses to increasing and decreasing crude oil prices.

Table 3

*(a) Variance decomposition money supply when oil prices are increasing*

Months	SE	Crude oil price	Petrol price	Exchange rate	inflation	Money supply	Real GDP	Interest rate
3	0.021904	0.456125	0.629211	0.067780	0.295655	95.08015	1.435677	2.035402
6	0.029819	1.592506	0.420716	0.055278	0.955037	87.78626	6.035559	3.154641
9	0.036533	1.457503	0.414837	0.039362	1.390031	82.29618	10.54025	3.861834
12	0.042596	1.178263	0.490804	0.077678	1.683195	77.74757	14.50831	4.314183

*(b) Variance decomposition money supply when oil prices are decreasing*

Months	SE	Crude oil price	Petrol price	Exchange rate	inflation	Money supply	Real GDP	Interest rate
3	0.023126	0.009897	0.955824	0.093944	0.760430	94.64815	1.387795	2.143961
6	0.031987	0.049710	1.110872	0.066927	1.659948	88.03464	3.955132	5.122775
9	0.038895	0.038759	0.947358	0.047607	2.379900	83.09469	6.007485	7.484197
12	0.044820	0.071233	0.779942	0.083183	3.047763	79.09882	7.748536	9.170524

It is also observed in Table 3 that the contribution of the monetary policy goals (inflation and real GDP) to variations in money supply may be higher or lower depending on whether crude oil prices are increasing or decreasing. Fluctuations in the rate of inflation account for a higher proportion of the variations in money supply when oil prices are decreasing (0.76 percent, 1.66 percent, 2.38 percent and 3.05 percent after 3, 6, 9 and 12 months, respectively) than when they are increasing (0.30 percent, 0.96 percent, 1.39 percent and 1.68 percent after 3, 6, 9 and 12 months, in that order); and real GDP fluctuations account for a higher proportion of the variations in money supply when crude oil prices are increasing (1.44 percent, 6.04 percent, 10.54 percent and 14.51 percent after 3, 6, 9 and 12 months, respectively) than when they are decreasing (1.39 percent, 3.40 percent, 6.01 percent and 7.75 percent after 3, 6, 9 and 12 months, respectively).

Table 4 presents the variance decomposition of interest rates, which are a primary tool of monetary policy in South Africa. The table shows that the largest proportion of the fluctuations in interest rates is explained by exchange rates, indicating that monetary authorities respond to exchange rate fluctuations by adjusting interest rates. It is further observed that the contribution of exchange rate fluctuations in interest rate variations is larger when crude oil prices are decreasing (94.71 percent, 91.88 percent, 90.67 percent and 90.01 percent after 3, 6, 9 and 12 months, in that order) and lower when crude oil prices are increasing (89.96 percent, 87.36 percent, 86.06 percent and 85.35 percent after 3, 6, 9 and 12 months, in that order). This is consistent with the earlier findings showing asymmetric responses of monetary policy to increasing and decreasing crude oil prices.

Table 4

*(a) Variance decomposition interest rates when oil prices are increasing*

Months	SE	Crude oil price	Petrol price	Exchange rate	inflation	Money supply	Real GDP	Interest rate
3	0.920528	1.276260	0.470851	89.95547	1.495163	0.357146	2.358365	4.086741
6	1.463284	1.173480	0.469867	87.36115	3.336404	0.421224	2.036842	5.201032
9	1.785700	1.204035	0.335305	86.05513	3.949414	0.387792	1.731946	6.336375
12	1.954113	1.396403	0.280471	85.34907	3.846459	0.372799	1.498073	7.256725

*(b) Variance decomposition interest rates when oil prices are decreasing*

Months	SE	Crude oil price	Petrol price	Exchange rate	inflation	Money supply	Real GDP	Interest rate
3	0.942167	0.126493	0.004783	94.70997	2.409648	0.098053	1.071339	1.579714
6	1.426094	0.851546	0.006596	91.88351	2.748090	0.099563	0.818353	3.592345
9	1.709151	1.356244	0.008917	90.67371	2.484000	0.087251	0.595556	4.794320
12	1.874482	1.676010	0.014019	90.01260	2.183737	0.084882	0.516184	5.512571

It is also observed in Table 4 that that money supply changes make a marginal contribution to variations in interest rates (less than 1 percent) in any period up to a year, whether crude oil prices are increasing or decreasing. The contribution of changes in the monetary policy goals (inflation and real GDP) to interest rate variations depends on whether oil prices are increasing

or decreasing. Inflation fluctuations account for a larger proportion of interest rate variations when oil prices are increasing (1.50 percent, 3.34 percent, 3.95 percent and 3.85 percent after 3, 6, 9 and 12 months, respectively) than when they are decreasing (2.41 percent, 2.75 percent, 2.48 percent and 2.18 percent after 3, 6, 9 and 12 months, respectively). Changes in real GDP changes also account for a larger proportion of the variations in interest rates when crude oil prices are increasing (2.36 percent, 2.04 percent, 1.73 percent and 1.50 percent after 3, 6, 9 and 12 months, in that order) than when they are decreasing (1.07 percent, 0.82 percent, 0.60 percent and 0.52 percent after 3, 6, 9 and 12 months, respectively).

## **5.4 Conclusion**

This chapter presented the results of the study and an analysis of the findings. The findings from the impulse response were compared to existing literature and it was found that they support each other. The study found a significant relationship between decreasing oil prices and real GDP and output. The relationship was found to be insignificant for increasing oil prices. It was concluded, therefore, that the relationship between oil prices and GDP in South Africa is asymmetric. Further evidence of asymmetric relationships is found among selected variables in the monetary policy transmission process using variance decomposition. The relationship among the operating tools, intermediate targets and goals of monetary policy tend to be different depending on whether crude oil prices are increasing or decreasing. The study also finds out that the interest rate and exchange rate channels are important in the transmission process of monetary policy in South Africa.

## **CHAPTER SIX**

### **SUMMARY AND POLICY RECOMMENDATIONS**

#### **6.1 Summary of the Findings with Empirical Comparisons in South Africa**

The study investigated whether the real effects of monetary policy are asymmetric in reaction to an oil price shock in South Africa for the period of 1994:1-2013:12. Using a Structural VAR, the study employs impulse response functions and variance decomposition analysis to investigate the relationship among selected variables in a prototype of South Africa's monetary transmission process. The study is done to show the response of one variable to another, to determine their contemporaneous and sluggish responses, in two separate experiments: one that captures only increasing crude oil prices and another with only decreasing oil prices.

Consistent with the existing theory and empirical literature, it is found that the reaction of output and inflation to an oil price shock is asymmetric. The nature of the asymmetry, however, is different to what has been found in most of the existing literature. In this study, an increasing oil price shock tends to stimulate output more than a positive oil price shock reduces output. Similarly, a negative oil price shock tends to ease inflation by a larger margin than a positive oil price shock increases the general price level. This proves that policy has leaned against the winds of international oil price changes to reduce volatility. Consistent with the empirical literature, the study also finds that inflation is less sensitive to oil price shocks (Hooker, 2002). This implies that the monetary policy regime is less accommodative to shocks (Taylor, 2000). In South Africa, the monetary policy regime changed in 2000 to inflation targeting.

The floating exchange rate allows a quicker recovery from external shocks, which increases the competitiveness of local goods on the international market since trade openness leads to lower volatility. The results further show that an oil price puzzle occurs when using the VAR approach, which is contrary to theoretical expectations (Bernanke and Blinder, 1992). The oil price puzzle was found even when using a structural VAR analysis, thus confirming that monetary policy in

South Africa is ineffective in stabilizing oil prices through exchange rates. This is because exchange rates insignificantly contribute towards explaining the fluctuations in world oil prices. Since the South African monetary policy framework has a floating exchange rate, an appropriate policy would be neutral monetary policy. Beyond taking a neutral stance, policymakers can influence the impact of oil prices by responding asymmetrically as well.

The study results also reveal that with decreasing oil prices, there is a transitory impact of non-response followed by a slight increase in money supply, which is nonetheless insignificant, in response to a positive interest rate shock. The implication is that a negative oil price shock has an insignificant tightening monetary policy. This implies that the monetary authorities in South Africa are slow at responding to a negative oil price shock, probably to ensure that inflationary pressure is minimized by money supply. On the other hand, increasing oil prices decrease both interest rates and money supply. The interest rate reflects an expansionary monetary policy. This policy suggests that policymakers are able to increase output while stabilizing prices. However, this monetary policy is also insignificant.

The findings from the variance decomposition analysis corroborate the findings of the impulse response functions. The study results show that the proportion of fluctuations in the rate of inflation that are explained by changes in crude oil prices is larger when crude oil prices are decreasing than when they are increasing. It is also found that the proportion of real GDP variations explained by fluctuations in crude oil prices is larger when crude oil prices are decreasing than when they are increasing. These findings are consistent with the impulse response analysis, indicating that inflation and real GDP respond asymmetrically to crude oil price fluctuations.

In addition, the study reveals that monetary authorities respond asymmetrically to crude oil price changes. When crude oil prices are increasing, monetary authorities respond with greater speed and adjust interest rates by larger margins than when crude oil prices are decreasing. This probably explains why increasing crude oil prices tend to have a smaller impact on inflation than decreasing oil prices. Thus, the monetary policy response to increasing and decreasing oil prices is a highly likely source of the asymmetric relationship between monetary policy goals and changing oil prices.

The study results further reveal that in South Africa, the contribution of the monetary policy goals (inflation and real GDP) to variations in money supply (an intermediate target of monetary policy) may be higher or lower depending on whether crude oil prices are increasing or decreasing. Fluctuations in the rate of inflation account for a higher proportion of the variations in money supply when oil prices are decreasing than when they are increasing; while real GDP fluctuations account for a higher proportion of the variations in money supply when crude oil prices are increasing than when they are decreasing. This shows that the monetary policy asymmetry observed in the operating tools and the goals of monetary policy can also be traced through the intermediate targets. Similarly, it is observed that exchange rates respond asymmetrically to monetary policy in the event of an increase or a decrease in crude oil prices.

It is further observed in the study that exchange rate variations account for a very large proportion of the fluctuations in inflation rates. It is also found that money supply accounts for a larger proportion of the fluctuations in real GDP than exchange rates, indicating that money supply may be a more important intermediate target of monetary policy than exchange rates in the transmission of monetary policy where the policy goal is real GDP. In addition, it is found that the proportion of fluctuations in money supply explained by interest rates variations is larger than the proportion explained by exchange rates; and the impact of the interest rates on money supply is also observed to be larger when oil prices are decreasing than when they are increasing. We, therefore, conclude that the money effect, interest rate, and exchange rate are important channels of monetary transmission in South Africa.

The study also reveals that the largest proportion of the fluctuations in interest rates is explained by exchange rates, indicating that monetary authorities respond to exchange rate fluctuations by adjusting interest rates. The impact of this response is observed in money supply variations, as argued in the foregoing discussion.

Finally, the overall results reveal that monetary authorities respond asymmetrically to external shocks to cushion their effect on the economy. An investigation of asymmetric effects of oil price shocks in South Africa is important for policy analysis in order to understand the magnitude, impact, timing and exact pass-through of the shocks to real GDP and inflation; and how monetary authorities have responded to these shocks. While several studies have been carried out on this subject, they are at best generalisations and equally provide oversimplified

guidance to policymakers. In particular, monetary authorities need to know the transmission channels in order to understand how oil price shocks affect the economy. Therefore, it is recommended that future research examines the impact of oil price shocks, concentrating on the transmission process to discover the complete structure of the transmission channels leading to the asymmetric relationships.

## **6.2 Policy Implications and Recommendations of the findings**

The analysis of the asymmetric effects of oil price shocks in South Africa is beneficial for policy purposes in terms of consolidating the basis on which to measure the intensity of the shocks. The understanding of the impending global oil price shocks that impact the economy and the actions taken by monetary authorities to control the global oil price shocks within the economy is essential. The findings of this study have shown that the asymmetric effects of oil price shocks and the effectiveness of monetary policy management in stabilizing the economy and cushion the effects of the global oil price shocks are observed in the operating tools and the goals of the monetary policy can also be traced through the intermediate target. Therefore, results from this empirical study have several implications for monetary policy.

First, the numerous analyses for the SVAR and the monetary policy variables employed for this study show the effectiveness of targeting one of the variables in influencing the behavior of the other variables to determine their contemporaneous and sluggish responses (as shown in the matrixes) is to ensure macroeconomic stability. Given the significant relationship between the growth of the economy and the monetary policy variable in this study, the stance taken by the monetary authorities, of pursuing a sound monetary policy and leaving the determination of the external value of the Rand exchange rate to the invisible hands of market forces in the economy has been justified. The floating exchange rate as a policy adopted by monetary authorities has a justification that the less flexible (rigid) exchange will be associated with slower growth (see Levy-Yeyati and Sturzenegger, 2003). However, the floating exchange rate is not insulated from external shocks (see Carlin and Soskice, 1990). Therefore, policy measures should be continually put in place to understand the asymmetric effects of oil price shocks that can adversely affect economic growth.

Second, an understanding of the impulse response functions derived from the SVAR will assist monetary authorities in their attempts to cope with uncertainties in the future arising from global oil price shocks. This analysis depends on mainly data from the past and an analysis of trends in order to direct policy response to stimulate economic growth. The impulse response functions clearly brings out the growth patterns (increase and decrease) emanating from the asymmetric effects of the global oil price shocks and can be justified and recommended to policymakers in calculating or in predicting the outcome of monetary policy actions for future development.

Third, when analyzing the impact of changes in the South African monetary policy on the economy, there is a temporary impact of an upward and downward spring of global oil price shocks to the economy. The implication is that, the oil price shock has an impact on economic activities, which turn to be asymmetric as revealed in this study in which the response of output and inflation to an oil price shock is asymmetric. This study finds that a negative oil price shock tends to stimulate output while a positive oil price shock has an insignificant effect on output. Similarly, it is observed that a negative oil price shock reduces inflation by a larger margin than a positive oil price shock increases the general price level. The policy recommendation suggests a continuous diversification of the economy and also that the monetary policy action should factor in the leading indicators of global liquidity for prices and economic activity. Taking into account the various channels especially the response of interest rates, money supply, exchange rates, real output and inflation to shocks in the system which may be larger or smaller depending on whether oil prices are increasing or decreasing.

Finally, when assessing the evolution of South African monetary policy as discussed in chapter two, the extensive regime changes and policy reforms from 1960 to date show that the rule was to achieve prices (inflation) stability and to reduce the output gap (unemployment). The inflation-targeting regime has been able to outperform other regimes due to its effectiveness in stabilizing the economy against domestic inflationary shocks and global oil price shocks. This has further accounted for its extension beyond 2008 to date, with the monetary authorities on track with their mandate of price stability and economic growth. As a policy decision by monetary authorities, the transmission of global oil price shocks to real output is evident in this study, but has however diminished overtime through the contractionary monetary policy of inflation-targeting (by keeping the target rate at 3-6%). Therefore, the policy recommendation is

that monetary authorities should sustain this policy and factor in the asymmetric effects of the global oil price shocks.

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