The impact of oil price shocks on stock market returns: Evidence from South Africa

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DECLARATION

I, Tapiwa Dennis Shonhiwa, declare that the research work reported in this dissertation is my own, except where otherwise indicated and acknowledged. It is submitted for the degree of Masters of Management in Finance and Investment at the University of the Witwatersrand, Johannesburg. This thesis has not, either in whole or in part been submitted for a degree or diploma to any other university.

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ABSTRACT

This paper seeks to determine whether there is any relationship between oil price shocks and the stock returns of South African firms. In recent periods, oil prices have risen significantly, and the price has been volatile. The volatility of oil price has drawn the attention of many researchers to study the impact oil supply and demand shocks on various economies. In this study shocks are split into three, namely crude oil supply shocks; shocks to the global demand for all industrial commodities; and global crude oil market demand specific, as opposed to a single oil price shock. This paper uses the vector autoregressive (VAR) model and the Vector Error Correction (VEC) models to quantify the effect of oil price shocks on South Africa's stock returns. The primary variables used are exchange rate (USDZAR), global oil production, global oil price and the South African real stock returns. Structural shock to the exchange rate significantly explains fluctuation in the stock returns in the South African stock market case for most of the oil consuming industries. This study discovers that shocks in oil prices can be used to estimate the simultaneous relationship between stock return and stock volatility. The study points that oil price shocks are negatively related to stock returns of sectors that consume oil in their production of goods and services. However, the contribution of oil production and oil price to the fluctuation of the all share index are not quantitatively significant.

Keywords: Volatility, oil price shock, Vector Error Correction Model (VECM), Vector Autoregressive (VAR)

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1. Introduction

This thesis disentangles the shocks in the global crude oil market and examines the demand and supply shocks' impact on the stock returns for different South African industrial sectors. Theoretically, investment under uncertainty and real options, such as uncertainty about oil prices will tend to depress current investment. Firms rely on investments for them to generate revenues, operating profits, residual income and add to the net worth of owners. If a firm is to post positive returns, this depends on the available assets being utilised to generate these returns. Having depressed or limited available investments to use in acquiring and optimising assets will tend to impact firms' ability to have positive stock returns.

Based on theory, discounted cash flows must be used to determine the price of assets (Fisher, 1930). Following this argument, it is expected that all factors that can cause a change in the projected discounted cash flows, will have a pronounced impact on the final price of a financial asset. An increase in oil price results in an increase in costs. This creates restrained profits for firms and results in decreased shareholders net worth. Therefore, oil price increase is expected to be followed by firms' stock price decreases (Filis *et al*., 2011). The financial markets ought to capture the economic effect of oil price shocks given their likelihood of affecting cash flows, expected firm returns and business investment decisions. This study will contribute to the existing literature by examining the effects of oil price shocks on the South African stock returns. There is vast literature available that looks at the impact of oil price shocks on different stock markets. However, there is a paucity in information that specifically looks at emerging market like South Africa. This thesis uses monthly data of global crude oil and JSE sectors stock prices for the period from January 2000 to December 2017. The study considers oil price denominated in both USD and Rands to measure oil volatility.

1.1 Problem Statement

High levels of import costs in South African companies are inevitably huge factors that lead to the problem of exchange rate pass-through in the pricing of final products to the firms and customers in the local market. Oil price shocks can affect firm value by influencing the discount rate for cash flow by altering the expected rate of inflation and the expected real interest rate (Hasan and Ratti, 2012). Demand and supply shocks determine oil prices. Firms' cash flows can be affected by crude oil price shocks because crude oil is an integral input in the production process for many industries and also since changes in prices of oil can potentially affect the demand for products that are produced in different industries in a nation. (Hasan and Ratti, 2012). Volatility is an intrinsic aspect of oil prices because it is extensively used as an input in many production processes and its regarded as a final consumption good (Swanepoel, 2006). Firms' performance can be affected by oil prices.

There is vast research available that examines the relationship between the volatility in the prices of oil, economic activity at national and global levels, firms' stock prices and returns, and oil price demand and supply shocks as well as various stock markets return movements. Diaz *et al*., (2016) studied the relationship between oil price shocks and stock returns specifically for the G7 economies. They found out that the global oil price shocks have more significant impact on stock markets as compared to the effect that the volatility in prices of oil at the national level has and that stock markets respond negatively to increased volatility in the price of oil.

The early papers on the subject have found a negative relationship between oil prices and stock market returns. These researchers include Hondroyiannis *et al*., (1998) for Greece, Sadorsky, (1999) for the U.S., and Jones and Kaul (1996) for Canada and the U.S.A. Research by Miller and Raiti (2009) studied the impact of oil price shocks on six Organisation for Economic Co-operation and Development (OECD) countries and established that their stock market indices respond negatively when oil prices increase over an extended period, mainly before the year 2000.

South Africa has insufficient oil reserves. About 60% of its crude oil requirements are met by imports from the Middle East and Africa as reported in the South Africa yearbook 2012/2013 Energy section. Given that South Africa is a net importer of crude oil, global oil price changes are expected to have an impact on its economy. Fofana *et al*., (2008) found that global oil price increases indeed have a negative effect on the economy of South Africa. If indeed oil price movements affect stock market returns in South Africa, then policymakers and investors need to find tools to safeguard the returns of the stock markets against this exogenous variable. Issues like the USD/ZAR exchange rate affect the landed price of oil price and policymakers in South Africa can use the exchange rate as a tool to influence the real price of oil for the ultimate users of the commodity in South Africa. For example, a stronger Rand can make the landed price of imported oil relatively cheaper since the global oil market set its prices in U.S dollars.

It is desirable for South Africa and other emerging economies to consider other sources of energy. Other sources of energy will help safeguard the economy and stock returns from oil price shocks. This recommendation will form the basis of this paper if indeed oil price shocks negatively affect returns and the economy of South Africa. Wakeford (2006) concluded that the economy of South African is affected by increased volatility in global oil prices. The impact of the most recently captured oil price shocks has contributed to South Africa’s higher inflation, influenced increases in interest rates and contributed to a slowdown in the growth of South Africa (Wakeford, 2006).

1.2 Purpose, Questions and Significance of Study

The findings of this study are crucial in that, policymakers and investors alike could use oil prices as a significant determinant in coming up with accurate projections of stock prices and returns. This is so because the study seeks to establish the existence of a correlation between variables such as corporate performances, oil price shocks, investment decision making, and resource allocation efficiency through reduced or increased stock market returns.

There is convincingly robust and growing literature that addresses the impact of oil prices on stock prices for developed markets. However, not so much research is available when it comes to studying this relationship for emerging economies. The Johannesburg Stock Exchange (JSE) is so much sophisticated and the most developed exchange in Africa and one of the most critical stock exchanges amongst the emerging economies. It is, therefore, crucial for investors, policymakers and participating firms to study and understand the factors that play a part in influencing the prices and ultimately the returns of firms in South Africa and mainly those trading on the Johannesburg Stock Exchange.

The critical questions to be addressed by this study are:

a) What is the impact of all oil price shocks, i.e. supply shock, aggregate oil demand shock and precautionary demand shock, on the South African Stock returns?
b) Do oil price shocks have varying effects on different South Africa sector based returns (Chemicals; All-Share Index; Mining; Forestry and Paper; Construction and Materials; Industrial Transportation; Food Producers; Telecommunications; Travel and Leisure).

There is not much research available that seek to capture the impact of a second change in prices of oil on stock market returns. Stock market returns are not only affected by the absolute change in oil prices but also the general instability of oil prices generates a response in the markets (Diaz *et al*., 2016). Most research on the topic of the impact of oil price on an economy's activity, focus on the direct long-term correlation of the movement of prices of oil and financial markets. Not much literature is available that seeks to measure the increase or decrease on the instability of oil prices and its impact on stock returns in an oil importing country like South Africa.

This research uses monthly data covering the period 2000:01 to 2016:12 and will seek to uncover that the impact of changes in the price of oil has an effect on the stock markets. This study will attempt to demonstrate that the impact is not only through price increases (or decreases) having an effect on expected cash flows or expected returns but the frequents and magnitude of the oil price change also enhance volatility. The approach adopted in this study is to measure the response of South African industrial stock markets to demand and supply shocks in the oil price and confirm that, as per the available theory, indeed increased volatility in the price of oil has a negative impact on the performance of stock markets in these sectors. The result is not the same for all sectors. The sectors that heavily rely on oil as a critical input for the production of services and goods suffer the most significant impact. The other sectors that depend less on oil as a critical production input see a moderate to no effect from the volatility of oil prices.

Emerging economies'stock market returns are affected negatively by oil price shocks (Raza *et al*., 2016). This study will test whether the same result holds for South Africa. The study will further examine whether the results indicate that the stock returns in South Africa are more susceptible to bad news and events than to good news. Raza *et al*., (2016) argued that bad news and adverse events that are as a result of uncertain economic conditions cause a much bigger effect in emerging economies' stock markets as compared to that of favourable events.

Most research papers have looked at positive relationships only. This paper will study the positive and negative relationships of global oil price shocks on the South African stock returns.

1.3 Background Literature

Many studies have been dedicated to exploring the relationship between oil prices and economic performance. This study will contribute to the existing literature in that it seeks to examine the effect of oil price in emerging economies concentrating on a net importing country, South Africa. The study aims to confine the impact of oil prices on sector stock market returns. The impact will be examined in nine different significant sectors in the South African economy, taken from the Johannesburg Stock Exchange.

If the oil price is increased, there will be two scenarios: First, consumers look for cheaper alternatives of energy and second, the production cost of firms that use oil as production input will be increased

(Basher *et al.,* 2016). When production costs rise, companies will seek to transfer this increased costs to consumers. This has an adverse effect on company performance in cases where consumers can find alternative products given the elasticity of demand for the concerned products.

Economists and analysts pay close attention to changing prices to minimising loss of revenue in the future because of price volatility (Donwa *et al*., 2015). Sharp, quick changes in oil prices can have enormous effects on economies and companies. A sudden rise in oil price has the potential to stunt economic growth. For an emerging economy that is a net importer of oil like South Africa, an oil price roller coaster can have damning effects on the fiscal budget.

Some research argues that supply and demand of oil have less effect on oil price shocks compared to financial speculation. At times of wide oil price movements, such as the 2007–2008 price spikes, the role of financial speculation in oil markets gets more attention than fundamentals such as supply and demand. Derivatives trading have been blamed for oil price shocks than real demand and supply of the commodity. Oil producers and traders take positions in the derivatives market to protect themselves from falling prices. Major consumers of energy, such as airlines and importing economies, will buy long positions in a bid to shed risk or they will hedge, in the futures market. Two major investors in oil can be noted; those that are speculative and those that are 'buy and sell' positions due to the nature of their business. Financial traders participation in oil price positions, provide volumes in the trading of oil and other commodities, which causes greater volatility.

Other than financial activity, another driver of oil price shocks is lack of inventory build-ups. South Africa as an economy should invest in infrastructure that facilitates oil inventory build-ups if it were to hedge itself against instant oil price shocks. Some of the drivers of oil price are exchange rate fluctuations, and keeping adequate oil reserves could assist significantly in shielding the economy and company stock returns from sharp changes in the landed cost of oil.

Miller and Raiti, (2009) studied the long run relationship that exists between the world crude oil price and the international stock markets. For this, they used a cointegration vector error correction model (VECM), and their results were not conclusive. Asaolu and Ilo, (2012) used the VECM to analyse the correlation of the price of oil and the international stock market and concluded that shocks on the oil price negatively affect the stock market returns.

Rabianajaf, (2016), examined the impact of international oil prices on the stock exchange of Malaysia. For this purpose, they used the data from 1999 to 2009 and applied the Vector Error Correction Model, and their results show that there is a relationship between international oil prices and stock exchange (Rabianajaf, 2016). They suggested that oil prices have both a bad and good impact on the stock exchange.

Policymakers can assist the economy and reduce its heavy reliance on international oil price movements by providing continued support for research into oil alternatives, such as biofuels and natural gas vehicles, and therefore affect the elasticity of crude oil demand in South Africa. The South African Petroleum Industry Association (SAPIA) reported in its 2015 Annual report that South Africa crude oil imports for years 2006 to 2015 were as follows, measured in thousand tonnes:

Table 1: South Africa, Crude Oil Imports

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
Volume ('000 tonnes)	22 090	21 067	25 040	19 254	17 834	18 940	18 658	21 279	19 233

Source: South African Petroleum Industry Association (2015), Annual Report

Sasol is an essential player in the local production of alternative energy to imported crude oil in South Africa. Sasol produces petrol and diesel from coal and natural gas using the Fischer-Tropsch process. Sasol is estimated to have consumed approximately 58 million tonnes of coal in 2006, one-third of South Africa's coal consumption, as the feedstock for its synthetic fuel and chemicals production. The World Nuclear Association (WNA) reported in 2017 that South Africa gets 40% of its oil/gasoline needs from coal-to-liquids plants. In the same report, the WNA point out that South Africa has two nuclear reactors generating 5% of its electricity. These are located in Koeberg Northern Cape Town and run by the state-owned electricity utility, Eskom.

1.4 Methodology

Elder and Serletis (2010), used a vector autoregressive (VAR) model. They modified their VAR to accommodate a generalised autoregressive conditional heteroscedasticity (GARCH). They conducted a study to examine the macroeconomic impact of the volatility of oil price. Their finding was that there is a negative reaction experienced on investments, the spending on durable products, and aggregate production. The consideration is that in particular, an effect on the economic activity of the volatility of oil prices must be captured through a look on the financial market performance.

This study takes the data from 18 years of both international oil prices, and stock exchange returns of South Africa. The data from 2000 to 2017 is considered and different models applied to analyse the impact of global oil price changes on the stock market return of the Johannesburg Stock Exchange (JSE). The stock market returns are taken as the main regressand, i.e. the dependent variable and the oil price movement is the primary regressor, i.e. independent variable. The indices include eight sectors from the JSE listed securities. The moderating variables are the exchange rate and global crude oil production levels.

Fluctuations on the prices of oil affect the economy’s financial sector through a variable which is the real USD exchange rate to the local currency; because it is indeed the effective prices that would be affected (Uwubanmwen and Omorokunwa, 2015). Therefore, the model used will hypothesise the stock return being depended on oil price movements, crude oil production as well as the exchange rate, USDZAR.

To investigate whether there is a co-integration or long-term relationship among global crude oil production, global oil price and U.S dollar exchange rate, an autoregressive distributed lag (ARDL) cointegration procedure, developed by Pesaran *et al*., (2001), will be used. The nonlinear Autoregressive Distributed Lag (ARDL) approach is applied to find short-run and long-run asymmetries.

VECM Pairwise Granger Causality test, exclusion and weak exogeneity test, forecast error variance decomposition, and impulse response will also be utilised in this study. The VECM Pairwise Granger Causality probes for evidence of lead-lag interactions among oil prices, stock prices in the eight South Africa industrial sectors, and exchange rates.

The steps that will be followed for the VECM methodology are:

a) Estimate an unrestricted VAR involving potentially non-linear stationary variables
b) Test for cointegration using Johansen (1988) test
c) Form and analyse the VECM

1.5 Outline of Study

The rest of this paper is structured as follows. Section 2 presents the literature review of the study that relates to the effect of oil price shocks on firms' stock market returns. Section 3 outlines the data implemented for this study and the research methodologies applied. The 4th Section presents the empirical findings of the investigation to address the objective of the study, by providing evidence on whether oil price has an impact or not, on South African stock returns. Section 5 presents the conclusion and recommendations that this study has unearthed.

2. Literature Review

2.1 Global Oil Price Market

The demand for oil for each country is a function of the country's economic activity, the price of oil and a time trend representing technological developments linked to energy efficiency (citation needed here). In the practical sense, oil producers do not swiftly act in response, if at all they do, to a flow demand shock on impact, given the related costs of implementing changes to oil production and the insecurity that surrounds the status of the crude oil market (Kilian and Park 2009). Since 1990 there has been growing interest on oil price shocks by both academics and policymakers, as the supply of oil in the market experienced a shift from the common problem of oil availability and witnessed a new question of deliverability and the investment challenge that dictate oil price dynamics to date (Fattouh 2006).

The Organization of the Petroleum Exporting Countries (OPEC) is the dominant oil producer. It is a permanent, intergovernmental Organization, created at the Baghdad Conference on September 10–14, 1960, by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. The five founding members were later joined by Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), Nigeria (1971), Ecuador (1973), Gabon (1975), Angola (2007), and Equatorial Guinea (2017). The mission of OPEC is to coordinate and unify the petroleum policies of its Member Countries and ensure the stabilization of oil markets. This is done to protect a proficient, economic and regular supply of petroleum to consumers, a stable income for producers and a relatively high return on capital for those investors in the petroleum industry (OPEC Statute, 2012).

OPEC asserted its oligopolistic power in the oil market by colluding on reduced production volumes and collectively setting the price (Van der Merwe and Meijer 1990). Although a demand curve that relates quantities to prices can accurately represent oil demand, modelling supply is more difficult. This is because oil is supplied by both a set of independent producers (non-OPEC nations) that act as price takers and an organization (OPEC) that uses a myriad of factors to determine levels of production and installed capacity (Dees *et al*., 2007). These aspects of OPEC production, along with changes in market conditions and OPEC behaviour, affect real oil prices (Kaufmann *et al*., 2008). OPEC's role in the oil market can be described by its two main actions, namely, a cartel model (in which OPEC is a price maker), and a competitive model (in which it is a price taker).

The values of the companies change as a function of the oil price because price volatility has a direct effect on companies' revenues, income, level of investments and the resultant cash flows (Boyer and Filion, 2007). Some research on oil markets examined a number of issues including estimation long-term oil prices (Haugom *et al*., 2016), pricing behaviour and political economy of the OPEC (Hochman and Zilberman 2015), the impact of fuel subsidies on crude oil prices and welfare (Balke *et al*., 2015), predicting growth in OPEC and non-OPEC production and real oil prices (Ratti and Vespignani, 2015).

Non-OPEC production has had a significant effect on OPEC's share of the world oil supply and, because of OPEC's ability to influence prices (Dees *et al*., 2007). Theoretically, oil market VAR models are structured under the assumption that any current production facility found in the oil-producing countries is permanent over a given period. The capability or readiness of oil producers to fiddle with their production levels to meet demand and smoothen any price changes is somewhat comparable to a shock in the supply of crude oil, using the global crude oil production as a proxy (Economou *et al*., 2017). Endogenous oil supply shocks take place within the crude oil market and is a complete reflection of the level of investment put in new production facilities, on the condition that oil producers remain optimistic about the future outlook of the oil market conditions and the possibility of price increases (Mabro and Fattouh, 2006). When oil consuming countries decided to remove regulations that controlled the supply of oil and oil imports, this forced the hand of the nations that export oil, leaving them without any but to allow the setting of oil price to be determined by the global market (Momani, 2008).

2.2 Oil price shocks

Oil price shocks can be defined as the level of unpredictability and risk associated with the magnitude of movements that are found in the prices of oil. Oil prices are said to have a higher volatility when they can implicitly be spread out over an extensive varying amount. Lower volatility in oil prices refers to moments when the oil prices are not fluctuating vividly but rather steadily moves up and down at a smaller rate over a period. Volatility can be taken as a measure of the variance or the standard deviation of the oil price.

Oil price shocks do not only have an impact on oil and gas producing companies. Higher oil prices result in increased inflationary pressures and successive depressed economic activity in oil -importing countries given that oil prices and economic growth have a negative correlation (Mork *et al*., 1994). The reason why higher oil price lowers the economic activity is that when the price of oil is increased the production costs of firms operating in nations that import oil significantly go up.

Given the importance of oil in the global economy, there is significant interest and research that seeks to study the effect of oil price changes to the economic growth and financial stability of economies (Diaz *et al*., 2016). Oil is a crucial resource as a source of energy, in modern day economics. Individuals require oil to power their vehicles. Again, individuals are affected daily by the prices of products that depend on oil prices. A change in oil prices will likely affect the disposable incomes of individuals, which in turn affect their purchasing power on any other products whether those products require or do not require oil to be produced. Oil is an essential input in the production processes,and it is essential to look at whether the volatility in the price of oil carries any weight to affect investment decisions. Investment decisions in periods with oil price shocks reduce the efficiency of resource allocations, and this is reflected in declining stock returns.

2.3 South Africa Equity Market

The Johannesburg Stock Exchange (JSE) was founded in November 1887. This was fourteen months after the pronouncement of the Witwatersrand Goldfields, to facilitate new mines and their investors to raise capital for the development of the mining industry. Over the years, companies that are more industrial joined the mining companies, and to date, more non-mining companies are listed on the JSE. The JSE is more vulnerable to the influence of events and trends in the global economy, in particular, those in other emerging markets (Van Zyl *et al.*, 2003). The role of financial markets and thus of the JSE is to allow listed companies that need capital (sellers of financial assets) to raise it; enable investors, sellers of capital (those with excess capital) to invest in financial assets, and allow both sellers and buyers to manage the risk of changing prices.

A fundamental theory in financial markets is called the efficient market theory. According to this theory, Security prices fully reflect all available information (Fama, 1991). Van Rensburg (1999) estimated the linear relationship between the JSE and four economic factors, namely the unexpected returns on the New York Stock Exchange, unforeseen changes in the term structure, unforeseen changes in commodity price and unforeseen changes in inflation expectations and his results indicated that all four factors significantly influence stock prices.

Rigorous studies in the literature have intended to investigate the oil–stock association across almost all the major international stock markets. Developing/emerging economies are becoming more involved in the global oil market, their stock markets are developing quickly, and interest in the link between oil shocks and emerging stock markets has grown (Zhang, 2017). Not much study has been carried out though, to establish the impact of global oil price shocks on South African stock returns. It is the prerogative of this study to explore the relationship between oil price movements on the Johannesburg Stock Exchange (JSE) sector returns. Investigating the effect of various shocks to the price of oil on sector returns, allows for a better analysis, having eliminated any company-specific shocks and allowing the influence to be analysed on a portfolio of assets within given sectors. The objective of the paper is to examine if there is empirical evidence that the volatility of oil prices do have an impact on the volatility of stock returns in an emerging economy using South Africa as a case study.

Stock returns respond differently to the changes in oil prices depending on whether the countries being looked at are oil importers or exporters. The classic supply-side model, suggests that oil price shocks have a potential to cause a stunt growth to an economy and kindle inflation for countries that are net oil importers while on the other side creating an increased revenue base for the oil-exporting countries through the wealth transfer effects. Oil price fluctuations are regarded as an exogenous shock in the economy of each country, and it has been stated that its impact on total production is significant (Dehaghi and Mirhashemi, 2015). Oil shocks are considered to be exogenous because research has shown that the shocks in oil prices *Granger precede* the rest of the major economic variables (Diaz *et al*., 2016). In this paper, the term 'Granger-precede' is used in the Granger (1969) causality sense. The expression that oil price shocks "Granger-precede" implies that they are not Granger-caused by other variables in the system. Granger-causality tests for all countries reveal that, except for the United Kingdom, oil prices Granger-precede both stock returns and output.

Stock market returns represent the movement in stock prices of companies. The companies' performances affect the stock prices, and that performance is a variable of a country's total production level and GDP, which are grossly affected by oil prices. Literature evidence shows that stock markets are sensitive towards oil price shocks too. For instance, the Financial Times on August 21, 2006, reported that the stock prices in America were reduced because of the increase in oil prices (Dehaghi and Mirhashemi, 2015). This study seeks to establish if such a relationship between oil prices movements and stock returns exist in South Africa. In developed countries, oil is considered one of the critical production factors and an increase in its price has had inflationary and recessional effects, and a decrease in its price is considered as the positive shock of the supply side (Dehaghi and Mirhashemi, 2015). There is not much literature that examines this relationship for developing economies, and this study will contribute and provide some insight on this subject in the South African economy.

From the last few decades, all the developing and under developed countries have been faced with the setback of oil shortages. This is the most significant issue affecting the economies of all nations (Najaf, 2016).

2.4 South African Rand Volatility

South Africa has its prices denominated in its local currency, the Rand across the entire economy and global oil price that the country imports is denominated in US dollar. The volatility of USD/ZAR, therefore, becomes important when analysing the impact of oil prices on the stock returns in South Africa. The currency volatility over the period January 2000 and December 2017 is examined in the study. The real exchange rate structural shocks are presented in figure 2 and the descriptive analysis shown in table 3.

The international market's crude oil price shocks may be amplified in specific countries than others, depending on the USD exchange rate to the specific countries' local currencies and current inflationary pressures (Uwubanmwen and Omorokunwa, 2015). This study examines the effect of oil prices movements on JSE stock market returns through USDZAR exchange rates. Oil price shocks reduce planning horizons, cause firms to push forward investments and require costly reallocation of resources (Rentschler, 2013). This produces an adverse effect on capital markets, the macroeconomy as a whole and consumer confidence (Chaibi and Gomes, 2014).

Commodity price volatility and global market uncertainty contribute to sprouts of Rand volatility (Arezki *et al*., 2012). Maveé *et al*., (2016) investigated what caused the USDZAR exchange rate volatility, and their results suggested that Rand volatility is mainly driven by global factors—expressed by commodity price volatility. As oil is one of the world most traded commodities, it follows that its price volatility is expected to cause instability in the Rand. Neither domestic macroeconomic surprises nor those originating from other Emerging Markets are statistically related to Rand volatility, a finding that is broadly in line with existing literature on emerging market currencies (Wong *et al*., 2016).

2.5 Microeconomic and Macroeconomic Channels

Most literature available categorises oil supply shock using the global crude oil production volumes, while using global economic activity to represent crude oil demand shocks, and the rest of oil demand shocks is categorised as idiosyncratic shocks (Diaz *et al*., 2016). Idiosyncratic oil demand shocks refer to those caused by movements in oil demand that has no relation to the summative world demand. These peculiar oil demand shocks negatively affects the stock market of countries that are net importers of oil (Guntner, 2014). For example, Kang *et al*., (2015) examined the effect that shocks have on the prices of oil have on determining the returns for the US stock market return and volatility and noted that the overflow indicator between the oil price shocks and the mean value of stock price volatility are substantial and have a high statistical significance.

The impact of oil price movements on stock returns can be explained through two primary channels, namely the microeconomic and macroeconomic channels. Based on theory, oil price shocks do affect stock market prices through their impact on expected income (Huang *et al*., 1996). The microeconomic channel is transmitted through the discounted cash flows. Oil significantly affects the cost of production since it is one of the critical inputs in most industries. The increased cost of production caused by punitive prices of oil have a negative impact on the profitability of companies, and the discounted cash flows are reduced, causing the stock prices and returns not to be so attractive (Muhtaseb and Al-Assaf, 2017).

Through the macroeconomic channel, the oil price movements may affect the stock returns through a higher or lower discounting factor used on the cash flows. When oil prices are high, in most cases the macroeconomy becomes highly inflationary. Most central banks will likely increase the interest rate to guard the economy against inflationary pressures (Basher *et al.*, 2016). When oil prices rise, cost of producing goods and services increase, and so do transportation and heating costs, which in turn lead to inflationary pressures and thus restricted consumption from consumers (Donwa *et al*., 2015).

Increased oil prices can raise operational costs of firms in some industries, which consequentially reduce their profit and thus result in lower stock prices. This channel is called the direct effect of oil shocks (Zhang, 2017). South Africa is an emerging market, which is a net importer of oil and oil products. Corporations operating in South Africa, who depend on oil products in any of their production, are likely to have their stock prices being directly affected by the price of oil.

Another indirect channel can be felt through the impact on systematic risk. Systematic risk is the uncertainty inherent related to the entire market, also known as un-diversifiable or market risk. The more a country is involved in oil-related trades, the more its economy becomes a subject of the fundamentals of price shocks on global commodity markets (Rentschler, 2013). This paper seeks to discover if any real shocks can influence the stock returns of South African companies due to oil price movements.

Microeconomic data will be set at industry level to analyse and demonstrate the significant correlations connecting oil price shocks and stock prices and returns. Increases in the prices of oil affect economic activity more than oil price decreases. The increases that follow a prolonged period of steady prices have a more significant effect than those that emerge as a simple correction of previous decreases (Hamilton, 2002).

When the oil supply is interrupted followed by an increase in the price of oil, spending on houses, appliances, cars and investment goods is expected to experience a temporary fall. When this happens, firms producing these goods are expected to suffer the most. In some cases, job losses and wage cuts are experienced, and this directly affects consumer spending and, consequently, company performances.

2.6 Disentangling Oil Price Shocks

In analysing the impact of oil price changes on stock returns, it is of importance to determine the source of the shock since not all oil shocks are similar. Kilian and Park, (2009) established that an increase in the price of oil that is caused by aggregate demand would result in an increase in the U.S. stock markets while those caused by oil-market specific demand shocks will result in a fall in the stock markets. This vital observation leads to the need for separating the types of shocks when studying or examining the impact of a commodity price on the stock market.

Oil price is affected by global demand and supply shocks. A global growth in economic activities, driven by emerging markets growing economies, pushes the aggregate demand shock for oil up. Political instability is a common feature in exporting countries, and there are not many prospects of discovering new oil reserves, causing supply shocks. This poses a challenge to the possibilities of increasing the supply of oil globally and creates precautionary demand shocks. The two factors combined; an increasing demand and a challenged supply of oil have effects of driving the price of oil up and increasing the volatility of the commodity.

When studying the impact of oil prices on market performance, it is important to point out the exact demand and supply shocks in the global crude oil market. Crude oil price shocks can be structurally decomposed into three different shocks, namely: Crude oil supply shocks; shocks to the global demand for all industrial commodities; and global crude oil market demand specific (Kilian and Park, 2009). The price of oil can also shift due to precautionary demand related to the concern raised about the future possible shortages in oil supplies. Different underlying cause of the oil price increase will create very different effects on the real price of oil. An increase in precautionary demand for crude oil will result in an instant, continual, and massive increases in the commodity prices. An increase in aggregate demand for all industrial commodities will result in a delayed, but continuous increase in the real price of crude oil that is also substantial (Citation needed here). Crude oil production disruptions cause a small and transitory increase in the real price of oil within the first year (Kilian and Park, 2009).

It is vital to know the cause of an increase in oil prices as this will help in predicting the implications of higher oil prices accurately. Decomposing unpredictable changes in the price of oil will help macroeconomists and policymakers to interpret oil price fluctuations and make informed recommendations to the government and firms on how to prevent this from damaging the firms' performance and the economy at large.

When analysing the impact of oil shocks on the economy, the preliminary analyses should originate from a production function that relates the outputs to the inputs, which include capital, labour and energy. An exogenous decline in the supply of energy-related inputs will directly reduce productivity, (Kim and Loungani, 1992); and changes in business markups (Rotemberg and Woodford, 1996), or capacity utilisation rates (Finn, 2000). Given this model, the log of real GDP should be linearly related to the log of the real price of oil. Therefore, if the price of oil decreases, it is expected that output will increase, whereas a reduction in the price of oil will result in a boom in the economy, which in turn should be transmitted to positive returns of stock markets. These models imply that there is a linear relationship between the log of real economic indicators and the actual price of oil.

3. Methodology and Data

3.1 Methodology

This section intends to quantify the impact of oil price shocks on South Africa's stock returns. For this, we use a vector autoregressive (VAR) model and the Vector Error Correction (VEC) models. Vector autoregressions (VARs) were introduced into empirical economics by Sims (1980), who demonstrated that VARs provided a flexible and tractable framework for analysing economic time series. The VAR model is a general structure used to describe the dynamic relationship between stationary variables. Variables are stationary if the time series' statistical properties such as mean, variance and autocorrelation are all constant over time. VAR is, therefore, suitable in cases where the variables applied in the study will be stationary or co-integrated. Variables are cointegrated when their relationship show evidence of stationarity even if the variables are not stationary individually. The cointegration property is viewed as a long run symmetry that occurs as a result of the impact that appears in the long term even if the variables are independent in the short term. When it is found that the variables are not stationary and that they do not not co-integrate, it becomes apparent to use VAR in the first differences in determining the relationship between variables.

The first step in analysing the time series in this study is to determine whether the levels of the data are stationary or non-stationary. If they are not, we will take the first difference of the series and try again. The VEC model is a unique case of the VAR used for variables that are stationary in their first differences known as I(1). If the variables have any co-integration relationship, the VEC is best suited to consider this.

We follow Kilian and Park (2009) and Apergis and Miller (2009) and adopt the following methodology. The methodology we adopted employs oil prices as an endogenous variable. It allows researchers in the area to detect the exact effects of oil prices fluctuations on some macroeconomic indicators, with stock prices an example of these. We use both vector error correction (VEC) and vector autoregressive; these two are the most used to investigate the effect of oil prices on macroeconomic variables. The unexpected change in oil prices is decomposed into orthogonal components. Oil prices are deflated by the US CPI to reflect what we refer to as real oil prices. The actual oil price is then orthogonalised for the effect of exchange rate fluctuations by converting the price from US dollar into South African Rand.

A conventional approach to modelling the impact of oil-price shocks is to use a bivariate, single-equation model of some aggregate variable, where total growth is determined by lags of itself and past innovations to oil prices (Engemann *et al*., 2014). Aye (2015) used a bivariate GARCH in mean VAR model for their study. They found that when oil price in US Dollars was used in the model, the results showed that volatility in prices of oil had a negative and slightly significant effect on stock returns. When they converted oil prices from US Dollars to South African Rands, they found that the impact, though negative, became significant at 5%. Based on this approach, in this study, we use the USD/ZAR exchange rate to convert the price of oil from USD to local Rand value.

Arouria and Nguyen (2010) used the VAR-GARCH approach and investigated the relationship amongst oil prices and stock returns in European countries at the industry sector level. They used weekly data between the first week of January of 1998 to the fourth week of December 2009. They found that there is a significant overflow effect amongst oil price and stock returns at the sector level.

Imposing a common identifying assumption in structural VARs substantially simplifies the variance function written regarding the structural disturbances (Elder and Serletis, 2010). We adopt the vector autoregressive and vector error correlation (VAR/VECM) model in this study instead. One of the notable advantages of using VAR/VECM model is that both approaches enable a researcher to perform innovation accounting. That is the researcher can numerically examine how one standard deviation shock in the error term of the specified oil price variable will affect a chosen set of endogenous variables included in the model as well as establish what percentage of the forecast error variance of a single variable is due to oil price shock.

3.2 Model Variables

The three variables that we employ in the case of South Africa are global crude oil production, world real oil price (oil prices deflated by the United States CPI inflation) as well as the USD/ZAR exchange rate. As compared to Kilian and Park (2009), we are more interested in oil-specific demand shock than the global oil demand shock. First South Africa is a net importer of oil, and second, USD/ZAR exchange rate influences the net price significantly in the acquisition of inputs from the international market. Shock to the exchange rate, therefore, may substantially affect input cost, the production cost and thus the stock market. The VEC form is specified as follows:

$$\Delta z_t = \gamma + \sum_{i=1}^{t} \alpha_i \Delta z_{t-1} + \mu EC_{t-1} + e_t$$

In the equation above, Z is a 3x1 vector of the variables - global crude oil production, world real oil price, as well as the USDZAR exchange rate, Δ represents the first difference operator, EC is the error correction term coming from the existence of co-integration of the three variables, e is a 3x1 vector of the residuals. If the long run relationship is nonexistent in the equation above, then the equation becomes a simple VAR model. If we set the coefficient of the error term, μ , to zero we come up with a VAR model as follows:

$$\Delta z_t = \gamma + \sum_{i=1}^{t} \alpha_i \Delta z_{t-1} + e_t \tag{1}$$

In the following lines, we defined ε as a vector of uncorrelated structural innovations that obey a structural order, such that:

$$\begin{pmatrix} e_{1t}^{global\ oil\ production} \\ e_{2t}^{real\ price\ of\ oil} \\ e_{3t}^{real\ exchange\ ratee} \end{pmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix} \begin{pmatrix} \varepsilon_{1t}^{oil\ supply\ shock} \\ \varepsilon_{2t}^{oil\ specific\ demand\ shock} \\ \varepsilon_{3t}^{other\ shocks\ to\ stock\ returns} \end{pmatrix} \tag{2}$$

The error structure in the above equation is ordered following Kilian and Park (2009) and was modified by Apergis and Miller (2009). In the equation above, it is assumed that the world crude oil production (used to represent oil supply shocks) does not respond to exchange rate shock in South Africa and to the global oil-specific demand shock. The second assumption is that the world real oil price (a proxy used to represent oil-specific demand shocks) reacts to oil supply shock but not exchange rate shock in South Africa. Thirdly, we assume that ZARUSD exchange rate shock (a proxy for idiosyncratic demand shocks) responds to oil supply shock and oil specific demand shock. The final assumption is necessary to show the importance of fluctuations that exist in precautionary demand for oil created by the concern around the availability of future oil supplies and the importance of strategies such as inventory policies (Apergis and Miller, 2009).

A principal feature of co-integrated variables is that their time paths are influenced by the extent of any deviation from long-run equilibrium (Enders, 2004). Elder and Serletis (2010) demonstrated that using a general identifying postulation in VAR makes simpler the variance utilisation written regarding the structural instability. We estimate our model by applying the logarithmic first differences of the real price of oil and real JSE stock returns (Kilian and Park, 2009).

The erogeneity of oil supply shock is prone to the assumption that there is the slow response of oil supply to demand shocks. Further, South Africa is a small open economy, and exchange rate fluctuation does not affect the global oil production. Furthermore, South Africa is a net importer of oil. The estimation procedure we adopted here follows Apergis and Miller (2009). We first estimate a three variable VEC or VAR model depending on whether there is a long or short run association between the variables using the level variable of the world oil production. The structural shock from the VEC or VAR model is recovered, we then combine it with a stock return to estimate four variables VAR for each one of the sector. In this analysis, eight different sectors are considered besides JSE all share index.

3.3 Data Description

This section describes the data with descriptive statistics and trend. The stock prices data we utilise in this study is obtained from Bloomberg. We also have data on the world oil production received from the US Energy Information Administration, and the USDZAR exchange rate also obtained from Bloomberg. We follow Barsky and Kilian (2004), and extrapolate data for the price of crude oil back to 2000:01, and deflate it using the US CPI inflation. We also collect data on the Johannesburg stock exchange all share index. We consider eight sectors in addition to the all share index; those are listed in table 3 below.

We use a data set that consists of monthly data for all the eight sectors, JSE all share index, oil price and oil production from the period January 2000 to December 2017. Other research studies that also take into account monthly data to study the impact of oil shocks on stock returns are Miller and Raiti (2009); and Apergis and Miller (2009) among others.

We consider alternative oil price specifications. These include the world nominal price and the nominal national price. The price given in US dollars per barrel is what we take to be the world nominal price while the South African nominal price of oil is assumed to be the product of the world price and the USDZAR exchange rate. Diaz *et al*., (2016) also considered national and global nominal oil prices. To measure stock returns, we utilise the monthly closing share price index for each sector. The stock return is then taken as the logarithm of the first differences of the series. This definition of real stock returns is similar to that provided in past empirical literature by Park and Ratti (2008) and Diaz *et al*., (2016).

Table 2 describes the industrial indices that we selected and used for the analysis. Eight sectors in addition to the JSE all share index were chosen for us to examine the effect of crude oil price demand and supply shocks at sector level rather than looking at individual companies stock levels.

Table 2: Indices Definitions

JALSH	All share index	A
JTRNS	Industrial transportation	B
JNCSV	Telecommunications	C
JMNNG	Mining	D
JLEHT	Travel and leisure	E
JFRPP	Forestry and paper	F
JFPPS	Food producers	G
JCHEM	Chemicals	H
JCBDM	Construction and materials	I
WOP	World Crude oil production	
RBOP	Real Brent oil price	
RexR	Real Exchange rates	

We selected sectors that are likely to consume more crude oil as an input in the production of goods and services, more than any other sectors. We provide a descriptive statistics of the variables involved in the regression analysis in Table 3. The first table provides descriptive statistics for the stock price of each of the eight industries we have selected.

To save space and reduce the table; we identify the industries using alphabetic letters. Tables 2 describe the sectors and provide a letter representing each sector, from A to I. In Table 3, these letters are then used in place of the full name of the industry, this is maintained for the rest of the study.

We have also presented the graphical illustration of the real share prices of each sector. These are shown in Figure 1. The real share prices are computed using the consumer price index. We have selected eight industries in addition to the all share index. We have 241 observations for all the variables.

Table 3: Descriptive Statistics (indices)

	A	B	C	D	E	F	G	H	I
Mean	269.5	1.08	49.07	249.1	34.61	240.1	40.49	123.5	0.35
Median	292.8	1.06	54.03	238.1	36.1	239.5	41.93	130.2	0.33
Maximum	420.7	1.72	92.41	536.6	64.16	472.5	78.04	202.2	1.06
Minimum	101.5	0.48	8.32	93.78	10.33	68.45	11.5	42.32	0.09
S-Deviation	97.55	0.37	22.97	98.5	13.66	95.26	19.1	44.62	0.23
Skewness	-0.26	0.05	-0.24	0.75	-0.19	0.34	0.02	-0.15	1.17
Kurtosis	1.61	1.77	1.96	3.05	2.26	2.31	1.76	2	3.84
Jarque-Bera	19.6	13.7	11.64	20.23	6.16	8.39	13.77	9.65	55.35
Observations	214	214	214	214	214	214	214	214	214

Notes: The table reports summary statistics of the JSE all share index (JALSH) and eight JSE sectors, Industrial transportation (JTRNS), Telecommunications (JNCSV), Mining (JMNNG), Travel and leisure (JLEHT), Forestry and paper (JFRPP), Food producers (JFPPS), Chemicals (JCHEM), Construction and materials (JCBDM). The series are return data- the first differences of the logarithm of prices. The sample runs from 31-01-2000 to 29-12-2017. By row, we report the mean, median, maximum and minimum value, standard deviation (SD), kurtosis, skewness, Jarque-Bera (JB) statistics, and the number of observations.

The average of all share index end of day price is R269.52 while it fluctuated between 101.49 and 420.70 that the data is highly spread out as measured by its higher standard deviation of 97.5. The all-share index is skewed left, indicating that its mean lies to the left of the median and mode. When we look at the sector of industrial transportation, the mean of share price was R1.08 for the period,and it fluctuated between R0.48 and R1.72. The distribution of the industrial sector is almost perfect since its skew is very close to zero, 0.05, and thus the median and mean are close to each other, at 1.06 and 1.08. Telecommunication share prices fluctuated between R8.32 and R92.41 with an average of R49.07. Its mean lies to the left of the mode and media have a negative skew of -0.24.

The mining industry had a giant swing in its price movement ranging between 93.78 and 536.6. The mining industry's share prices have a normal bell curve, which was neither peaked nor flat, as indicated by its kurtosis of 3.05 which was very close to the ideal measure of 3. The end of day share price for the travel and leisure sector had a relatively smaller standard deviation of 13.66 indicating that it did not have a wider range as shown by its minimum of 10.33, a maximum of 64.16 and an average of 34.61. It was slightly skewed to the left, with a skewness of -0.19. Besides mining, share prices in the industry of forestry and papers also fluctuated a lot with a minimum share price of R68.45 and reaching a maximum of R472.52, giving a mean of 240.1. As expected, the standard deviation was as high as 95.26. The prices of the forestry and paper sector were skewed to the right, as shown by its positive skewness of 0.34.

Share prices of food producers sector had the least variability, and the skewness was 0.02 having fluctuated between 11.5 and 78.04 and posting a mean of 40.49. The minimum share price of the chemicals sector was 42.32, and the maximum was 202.2 with a mean of 123.5. The share prices were slightly skewed to the left, the skewness was -0.15, and concentrated around a single value as the kurtosis was 2.00 which is close to 3, which is the kurtosis of a standard bell curve. The construction and materials industry had its share prices ranging between 0.09 and 1.06, and the mean was 0.35. The share prices had a standard deviation of only 0.23 and skewness of 1.17 indicating a normal distribution with a small skewness towards the right and almost standard bell curve, as its kurtosis was 3.84.

Table 4 shows the descriptive statistics of the world oil production, USDZAR real exchange rates and the real Brent price. The oil production is taken as the world crude oil production measured in barrels per day, and the monthly closing data is used for the analysis. A barrel of oil is equal to 159 litres.

Table 4: Descriptive Statistics (macroeconomic variables)

	WOP	ROPB	RexR
Mean	74548.05	0.30	0.10
Median	75674.43	0.27	0.09
Maximum	89115.78	0.60	0.19
Minimum	60133.11	0.11	0.06
S-Deviation	5434.924	0.13	0.02
Skewness	-0.831067	0.41	1.53
Kurtosis	3.246008	1.88	5.61
Jarque-Bera	25.40886	17.07	144.02
Observations	214	214	214

Notes: The table reports summary descriptive statistics of the World Crude oil production (WOP), Real Brent oil price (RBOP), Real exchange rates (RexR). The series are return data- the first differences of the logarithm of prices. The sample runs from 31-01-2000 to 29-12-2017. By row, we report the mean, median, maximum and minimum value, standard deviation (SD), kurtosis, skewness, Jarque-Bera (JB) statistics, and the number of observations.

From table 4 above, we notice that the world crude oil production levels for the period under consideration fluctuated between 60,133.11 and 89,115.78 with a mean of 74,548.05. The world production levels of crude oil are concentrated around a single value as assessed by the kurtosis which is very close to 3, with a value of 3.24 and is slightly skewed to the left, and their skewness is -0.83.

The oil price is measured using the world Brent oil price. This price is divided by the US CPI to give the real world Brent oil price. The mean of the real world Brent oil price is 0.3, and it fluctuated between 0.11 and 0.6. The prices are skewed to the right, with a skewness of 0.41. This result is expected given that the production levels are biased to the left. As production levels decrease, this pushes the prices up, until the market corrects itself to an equilibrium price.

We have also presented the cross-correlation between the share prices of the selected industries.

Table 5: Correlation Matrix

	A	B	C	D	E	F	G	H	I
A	1	0.65	0.51	**0.76**	0.62	0.56	0.66	**0.77**	0.61
B		1	0.54	0.37	0.75	0.3	0.71	**0.8**	0.47
C			1	0.2	0.61	**(0.14)**	0.34	0.55	0.42
D				1	0.35	0.44	0.45	0.53	**0.7**
E					1	0.19	0.65	**0.76**	0.63
F						1	0.22	0.49	0.21
G							1	0.56	0.47
H								1	0.66
I									1

When we look at the correlation between specific industries and the all share index, we realise that there is a moderate relationship between the all share index and the other sectors. Only the mining and chemicals sectors have coefficients of correlation above 0.7, seating at 0.76 and 0.77 respectively. The other sectors display a coefficient of correlation to the all share index that lies between 0.5 and 0.7

When we look at the relationship between sectors; the chemicals sector is highly correlated with the industrial transportation sector, with a coefficient of correlation of 0.8 and 0.76 relating to travel and leisure. The mining sector correlated with construction and materials; with a coefficient of correlation of 0.7 and no, any other sector displayed a coefficient of correlation more than 0.7. Only Forestry and paper shows a negative relationship to telecommunication of -0.14, amongst the selected industries.

We present figure 1 to examine the movement of the share prices.

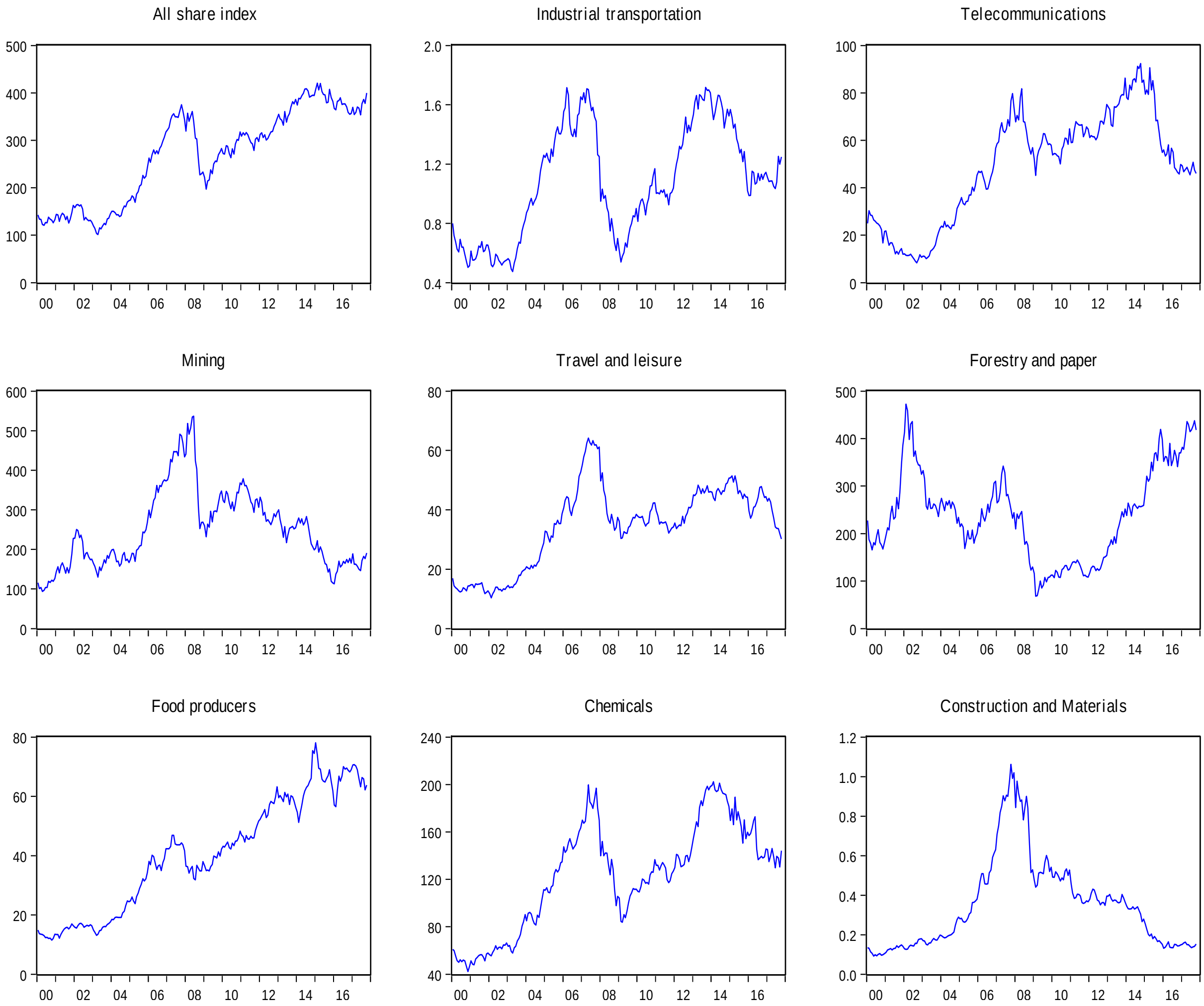

Figure1: Real Prices of All-Share Index and Selected Industries

Looking at the graphical illustration of the share prices, as shown in figure 1, most of the selected sectors were affected by the financial crisis of 2008. For example, the price in the industrial transportation sector fell sharply during the crisis while the telecommunication sector fell with moderation. The same moderated impact is realised in the industry of travel and leisure while the food sector was not as affected as the other sectors.

3.4 Unit Rood Test

When a time series has a constant mean and constant variance over time, then it is referred to as being stationary. Also, the covariance amongst the variables will not be dependent on the observed time, but on their lag time length. We take a simple auto-regression model of order one, written as, AR(1) model:

$$y_t = \emptyset y_{t-1} + e_t \tag{3}$$

Where e_t is a random noise process with zero mean and constant variance and $\emptyset$ is the parameter to be estimated. The stationary condition of the model is $|\emptyset|<1$. For the cases where $|\emptyset|=1$, the series is non stationary and it is referred to as a random walk model:

$$y_t = y_{t-1} + e_t \tag{4}$$

The above equation is referred to as a random walk, meaning, the time series tends to wander randomly, either downward or upward in an unpredictable manner. The past movement of the variable cannot be used to predict its future movement. In as much as the random walk series has a constant mean, in comparison with stationary variables, it has an increasing value of variance, which will eventually turn to infinite. The implication is that the series might not revert to its mean even though the mean is constant.

Given that the data is a time series, we employ the Augmented Dickey-Fuller (ADF) test and use Akaike information criteria (AIC) for the lag length selection. We test whether the variables have unit root for each industry.

Unit root can be defined by subtracting y_{t-1} from both sides of the auto regression model to give:

$$y_t - y_{t-1} = y_{t-1} - y_{t-1} + e_t \tag{5}$$

$$\Delta y_t = e_t \tag{6}$$

A series is integrated of order one and contains a unit root, if y_t is non stationary but Δy_t is stationary, such that:

$$\Delta y_t = y_t - y_{t-1} \tag{7}$$

Using Dicky-Fuller, we test the existence of a unit root. The essence of the test is to determine the value of $\emptyset$, from the AR(1) model, and test whether it is equal to one, or it is less than one. The null hypothesis tested here is: variables are non-stationary against the alternative hypothesis of stationary variables.

The null hypothesis: H_0: $\emptyset = 1$ and

The alternative hypothesis:H_1: $\emptyset < 1$

$$y_t - y_{t-1} = \emptyset y_{t-1} - y_{t-1} + e_t \tag{8}$$

$$\Delta y_t = y_{t-1}(\emptyset - 1) + e_t \tag{9}$$

$$\Delta y_t = \gamma y_{t-1} + e_t \tag{10}$$

Where $\gamma = (\emptyset - 1)$. Now the hypothesis is as follows:

H_0: $\gamma = 0$: The series is non-stationary or contains a unit root test

H_1: $\gamma < 0$: The series is stationary

Where if $\gamma = 0$, then $y_t$follows a pure random walk

3.5 Cointegration Test

After checking whether all the variables contain unit root or not, we proceed to test for co-integration. Variables are referred to as having a co-integration relationship when they demonstrate a stationary linear arrangement, even if the variables are non-stationary on an individual basis. Although the variables will rise (because they are trended), there will be a common trend that links them together.

If we take the simple model:

$$y = \emptyset x \tag{11}$$

We can solve for y if we know the value of x. Thus regardless of the initial value of y the dynamic solution of y will eventually converge on a unique value. However, if we have the model in first differences:

$$y_t - y_{t-1} = \emptyset(x_t - y_{t-1}) \tag{12}$$

The solution for y is not unique given x, because we can not solve for y without knowing the past value $(t-1)$ of y and x.

Suppose we have two variables X and Y. If these two variables are non-stationary, then we can represent the error as a combination of two cumulated error processes. If we have a case whereby X and Y are related then the expectation is that they will move together and when they are combined, it should be possible to find a combination of them, which eliminates the non-stationary. If this holds, we say that variable X and Y are cointegrated. Theoretically, this should only happen in the case where there exists a relationship linking the two variables together.

For the co-integration test, we use the Johansen and Juselius (1990) test. Before proceeding with the Johansen (1988) analysis, it is imperative to make a selection for the most suitable lag that can be obtained from the VAR equation. The amount of lags determined from the VAR equation influences the result of the cointegration test. We used Akaike information criteria to come up with the appropriate lag.

The Johansen (1988) approach follows two test statistics to test for cointegration. These two tests are the trace test and the maximum eigenvalue test:

I. <u>Trace test:</u>

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} ln(1-\hat{\lambda}_i) \quad (13)$$

This represents a joint test, and the hypothesis is presented as follows:

H_0: Co-integration vectors $\leq$ r

H_1: Co-integration vectors $>$ r

II. <u>Maximum Eigenvalue test</u>

$$\lambda_{(r,r+1)} = -T \ln\left(1-\hat{\lambda}_{r+1}\right) \quad (14)$$

This represents the separate test for each eigenvalue with the hypothesis presented as follows:

H_0: Co-integration vectors $=$ r

H_1: Co-integration vectors $= r + 1$

In the tests I and II, *r* is taken to represent the number of co-integrating vectors considered for the null hypothesis and $\hat{\lambda}$ is the estimated value for the *i*th ordered eigenvalue. It follows that, the larger the $\hat{\lambda}$ the lager the tests statistic will be. This is because in both equations, when we have a larger $\hat{\lambda}$, it follows that we will have a bigger and more negative $\ln(1 - \hat{\lambda}_{r+1})$. When we have a none zero eigenvalue, then it follows that we have a significant co-integration vector.

4: Empirical results and analysis

4.1 Unit root test results

Before presenting the unit root test results, we first extract the structural shock of the three variables VAR model, which is later combined to form the four variables VEC or VAR model depending on the co-integration results. The structural shocks are graphically illustrated as follows:

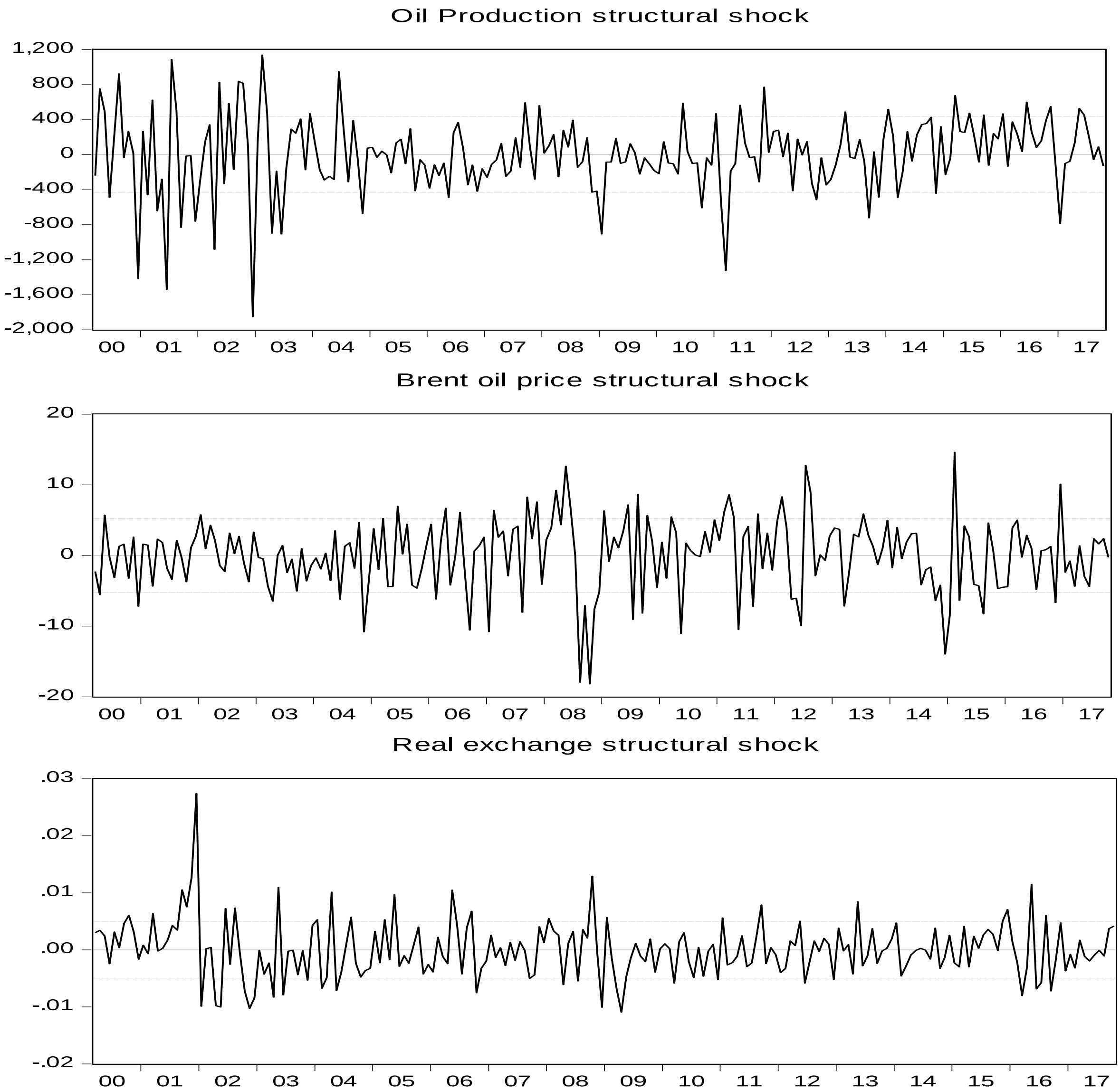

Figure 2: Structural Shocks

Oil production structural shock showed much volatility between the period 2000 and 2003, the same is observed for the real exchange rate in South Africa, while all the structural shocks showed much volatility during the financial crisis of 2008.

The unit root test is presented in Table 6.

Table 6: Unit root test

	Pane A			**Pane B**		
	Level			1^{St} Difference		
	x	**Y**	**Z**	**x**	**y**	**z**
A	2.24	2.27	2.05**	6.53***	6.51***	6.55***
B	2.83*	2.97	2.75***	5.90***	5.89***	5.91***
C	2.32	2.38	2.30**	15.83***	15.83***	15.86***
D	2.62*	2.6	2.64***	6.67***	6.71***	6.68***
E	1.65	2.53	1.57	7.28***	7.42***	7.30***
F	2.91**	3.26*	2.93**	5.92***	5.94***	5.92***
G	2	2.38	1.64*	7.38***	7.37***	7.39***
H	2.75*	3.04	2.59***	15.01***	14.99***	15.04***
I	2.1	3.15*	2.11**	4.12***	4.10***	4.14***
$\boldsymbol{\varepsilon^{wop}}$	14.58***	14.71***	14.62***	11.13***	11.12***	11.16***
$\boldsymbol{\varepsilon^{rbop}}$	14.49***	14.46***	14.53***	12.23***	12.20***	12.26***
$\boldsymbol{\varepsilon^{rexr}}$	14.39***	14.41***	14.43***	9.60***	9.59***	9.62***

Augmented Dick and Fuller (ADF) test with intercept (X), intercept and trend (y) and none (z) are reported. ***, **, * represent significance at 1%. 5% and 10 % levels respectively.

The ADF test indicates that all the stock prices, at the level, the all share index and the other eight JSE sector returns are non-stationary (Panel A of Table 6). However, the first differences are all stationary (Panel B of Table 6). Therefore, the series are used in their first differences (returns). Monthly data, covering the period 200:01:01 to 2017:12:29, are used. Previous related studies such as that by Cunado and Gracia (2014) confirmed the unit root property in economic activities, exchange rates, stock returns and price of oil.

The unit root test that is presented in table 6 shows that variables contain a unit root. After taking the first difference, all the price variables for the industries are stationary after 1st difference, but the structural shock variables are stationary at level.

4.2 Co-integration Tests Results

Table 6 presents the results using the maximum eigenvalue and the trace statistic tests. The results for cointegration analysis indicates that, apart from the all share index, which shows that the variables are co-integrated, this hypothesis is rejected for the other eight industries and we found no cointegration for all the eight sectors.

Table 7: Co-integration Tests

	Maximum Eigenvalues				Trace Statistics	
	r	n-r	Max-Eigen stat	Critical-stat	Trace stat	Critical-stat
A	r=0	r=1	29.4	27.58	48.1	47.85
	r<=1	r=2	13.58	21.13	18.7	29.79
	r<=2	r=3	4.26	14.26	5.11	15.49
B	r=0	r=1	18.77	27.58	36.18	47.85
	r<=1	r=2	11.47	21.13	17.41	29.79
	r<=2	r=3	5.13	14.26	5.93	15.49
C	r=0	r=1	25.34	27.58	43.48	47.85
	r<=1	r=2	11.56	21.13	18.14	29.79
	r<=2	r=3	5.58	14.26	6.57	15.49
D	r=0	r=1	26.28	27.58	43.32	47.85
	r<=1	r=2	11.96	21.13	17.03	29.79
	r<=2	r=3	4.18	14.26	5.07	15.49
E	r=0	r=1	17.53	27.58	31.6	47.85
	r<=1	r=2	8.98	21.13	14.06	29.79
	r<=2	r=3	4.57	14.26	5.07	15.49
F	r=0	r=1	19.14	27.58	39.74	47.85
	r<=1	r=2	15.3	21.13	20.6	29.79
	r<=2	r=3	4.7	14.26	5.3	15.49
G	r=0	r=1	18.68	27.58	40.17	47.85
	r<=1	r=2	16.1	21.13	21.49	29.79
	r<=2	r=3	4.8	14.26	5.39	15.49
H	r=0	r=1	20.08	27.58	39.96	47.85
	r<=1	r=2	13.88	21.13	19.87	29.79
	r<=2	r=3	5.24	14.26	5.99	15.49
I	r=0	r=1	16.94	27.58	27.58	47.85
	r<=1	r=2	10.65	21.13	21.13	29.79
	r<=2	r=3	3.93	14.26	14.26	15.49

We present both the trace statistics and the eigenvalues. For the all share index, which is identified by (A), the computed trace statistic is greater than the critical trace statistics, indicating at least one cointegration relationship. When we look at the trace statistics and the eigenvalues for the chosen eight industries, we see that the critical trace statistics and the critical eigenvalues are higher than the computed trace statistics and eigenvalues. This, therefore, indicates no cointegration relationship at the industry level.

The results, therefore, imply the use of vector error correction for the all share index and vector autoregressive at the industry level. The purpose of this study is to analyse the impact of the global oil fluctuation on the domestic share prices; we follow Sadorsky, (1999) methodology for the steps that are taken in this paper.

4.3 Variance Decomposition Tests

The results of the variance decomposition are shown in table 7. The disturbances e_{1t}^{OP}, e_{2t}^{OPR}, e_{3t}^{REXR} and Returns, represent the shocks to errors on changes in crude oil production, real oil prices, changes in USDZAR exchange rate and real stock returns respectively. Our study is similar to the one provided by Apergis and Miller (2009), we follow these authors and report the variance decomposition results obtained from the VEC model for the all share index and VAR results for specific industries. The VEC and VAR results are estimated following Monte-Carlo specifications with 1000.

When we look at the all share index, we see that the structural shock from the real exchange rate explains 1.32% of the fluctuation in the first three months, 3.64% one year after, 3.80% three years after and 3.83% five years later. The contribution of crude oil production and oil price to the fluctuation of the all share index are not quantitatively significant.

Table 8: Variance Decomposition

Industries	Months	e_{1t}^{OP}	e_{2t}^{OPR}	e_{3t}^{REXR}	Returns
All share index	3	0.2	0.01	1.32	98.45
	12	0.11	0.02	3.64	96.21
	36	0.08	0.01	3.8	96.09
	60	0.08	0	3.83	96.07
Industrial transportation	3	0.9	1.31	0.76	97.01
	12	0.41	4.26	4.24	91.08
	36	0.36	4.44	5.01	90.08
	60	0.36	4.44	5.12	90.05
Telecommunications	3	0.21	0.02	1.06	98.7
	12	0.14	0.31	1.38	98.15
	36	0.13	0.32	1.41	98.12
	60	0.13	0.32	1.42	98.11
Mining	3	0.02	0.42	1.3	98.31
	12	0.03	0.7	1.16	98.11
	36	0.03	0.72	1.17	98.06
	60	0.03	0.72	1.17	98.06
Travel and leisure	3	2.24	0.01	2.56	95.18
	12	2.91	0.45	4.78	91.83
	36	2.97	0.5	5.01	91.5
	60	2.97	0.5	5.02	91.5
Forestry and paper	3	0.04	0.47	1.15	98.32
	12	0.03	0.3	2.97	96.68
	36	0.03	0.3	3.07	96.68
	60	0.03	0.3	3.07	96.68
Food producers	3	0.28	1.29	0.24	98.17
	12	0.72	6.05	0.76	92.44
	36	0.78	6.17	0.77	92.26
	60	0.78	6.17	0.77	92.26
Chemicals	3	0.29	0.1	1.08	98.51
	12	0.44	1.94	0.47	97.13
	36	0.4	2.28	0.36	96.92
	60	0.41	2.3	0.36	96.91
Construction and materials	3	1.09	1.13	0.54	97.23
	12	0.6	2.04	1.76	95.58
	36	0.54	2.01	2.18	95.26
	60	0.53	2	2.22	95.23

In the sector of industrial transportation, we notice that real-world oil price and the real domestic exchange rate are both quantitatively crucial in explaining the fluctuation in the industry stock returns. In the first three months, world real oil price and the real exchange rate illustrate 1.36% and 0.76% of the real stock returns respectively. Twelve months after, real oil price explains 4.26% while the real exchange rate explains 4.24% of the fluctuation in the real stock returns. Three years after the shock, 4.44% of the fluctuation is described by the real world oil price while 5.01% is attributed to the real exchange rate. The results are almost invariant five years after. This implies that, because the sector of industrial transportation consumes much oil, the real global price of oil has a direct effect on the industry stock price; this may manifest itself via input cost. Secondly, if the exchange rate depreciates, this also increases the monetary values of the total cost because more Rand is required to buy the same amount of foreign currency denominated inputs. Shock to crude oil production does not explain much fluctuation in the real stock return in the sector of industrial transportation.

Only the real exchange rate shock explains the fluctuation in the telecommunication industry and the mining industry. When we look at travel and leisure, we realise that crude oil production and the real exchange rate are quantitatively significant and explain more of the fluctuation in the real stock returns for the industry. In the first three months, a shock to crude oil production and exchange rate explain 2.24% and 2.56% respectively. One year after, 2.91% of the fluctuation in real stock returns is explained by crude oil production while the real exchange rate explains 4.78%. The contribution of these two variables one year after, remain constant but are the most important factors explaining fluctuation in the real stock returns in that industry. The industry of forestry and papers is also driven by the exchange rate while the real oil price shock mainly drives the industry of food production and chemicals. Finally, construction and materials are primarily driven by the real oil price and the real exchange rate.

Our first remark is that structural shock to the real exchange rate significantly explains fluctuation in the real stock returns in most of the selected industries. Secondly, the sector that consumes much oil such as industrial transportation is affected by the real price of oil while travel and leisure are affected by oil production. Further, food producers and chemicals are affected by the real oil prices while construction and materials are affected by both real oil price of oil and the exchange rate.

5. Conclusion and Recommendation

5.1 Conclusion

This study's focus is on examining the impact of various global crude oil price shocks on the stock returns of different South African industrial sectors using the VAR model. We use monthly data from January 200 to December 2017 in this study. The study finds that oil price shocks can be used to forecast the simultaneous relationship between stock return and stock volatility. Oil price shocks are negatively related to stock returns of sectors that consume oil in their production of goods and services. The contribution of oil production and oil price to the fluctuation of the all share index are not quantitatively significant. This is so because other price factors in the economy, such as wages, interest rates, information technology, other major industrial inputs like metals and plastics can subsequently substitute the effects caused by oil prices movements. Another reason why the contribution of oil production and oil price in determining the fluctuations of all share index are not quantitatively significant is that, when firms make use of future markets they can be better position themselves in terms of oil stocks, production processes and thus in the process be able to hedge against any oil price fluctuations.

The study reviews that oil price shocks can have an impact on stock price through demand for goods and services produced by firms and through the effects on the cost of production. It is observed from the results of this study that structural shock to the real exchange rate significantly explains fluctuation in the real stock returns in most of the selected industries. A significant finding noted is that the sector that uses oil mainly as an input, such as industrial transportation has its real return being affected more by the real price of oil while travel and leisure are affected by oil production levels.

The explanation of VAR is done through variance decompositions analysis. Generally, variance decompositions analysis demonstrates the fact that, own shocks explain mainly the projected error variance for the entire set of variables. A significant observation from this paper is that changes in the price of oil can be used to explain economic activities levels. However this does not hold when examining the impact of economic activities on the price of oil.

Another finding demonstrated by this study is that positive oil price shocks generate a weaker economic outlook because of two reasons. The first one is that the increase in oil prices negatively impacts the South African stock return. The second reason is that positive shocks on oil prices cause a decline in the production levels of industries. Crude oil producing countries will be forced to decrease the supply of oil for them to cut losses thereby generating a negative impact on industrial production. When oil production levels decrease, importers and consumers of oil alike, create precautionary demand shock by overstocking oil thereby putting more pressure on the supply shock. This process explains the three shocks namely, demand shock, supply shock and precautionary demand shock.

5.2 Recommendations

South Africa's monetary policy is primarily inflation targeting aimed at maintaining price stability for sustainable economic growth. For South Africa to be able to hedge itself and protect the economy from volatile oil price shocks, it is essential for the country to adopt a policy of carefully considering optimal oil stock levels in line with accurately determined oil futures market and prices forecasts. Since firms that use oil and oil products as their primary production input are not spared from the effects of oil price shocks, they should consider investing in oil futures markets and take positions to hedge against oil price shocks.

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