ECONOMIC RISK EXPOSURE IN STOCK MARKET RETURNS: A SECTOR APPROACH IN SOUTH AFRICA (2007-2015).

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DECLARATION

I declare that the dissertation titled “**Economic risk exposure in stock market returns: A sector approach in South Africa (2007-2015)”** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

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ABSTRACT

South Africa had targeted the oil and gas sector for investment through the industrial action plan as a special economic zone. However, certain economic fundamentals might negate the anticipated sector financial development. This study investigate how economic risk exposure influence oil & gas sector stock market returns from 2007 to 2015 on a monthly basis. The four macroeconomic variables used to measure economic risk exposure are Brent crude oil prices, the USD/ZAR exchange rate, broad money supply and gold prices. The adopted techniques include the GARCH model to incorporate volatility, the Johansen cointegration and Granger causality techniques.

The results of the study found that change in Brent crude oil prices and broad money supply had a positive and significant impact on changes in oil & gas sector stock returns. Changes in exchange rate and gold prices had a negative and significant impact on the sector returns. The long-run relationship established one cointegrating equation in the series. Only Brent crude oil prices indicated a bi-directional Granger causality on the sector returns.

Based on the findings, it is recommended that government may use exchange rate as a policy tool to attract interest in the sector. Regarding money supply, the reserve bank should further preserve its effective regulatory infrastructure including the laws, regulations and standards towards the achievement and maintenance of a stable financial system. Portfolio managers, risk managers and investors should monitor the gold price to mitigate losses due to its strength as a safe haven asset.

KEY CONCEPTS: Stock returns, Oil prices, exchange rates, broad money supply, gold prices

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CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND

The integrated annual Johannesburg Stock Exchange (JSE, 2015) report outlines that, the stock market provides primary and secondary market, as such, is a key organized feature of South Africa's economic background. To this effect stock market share prices play a significant role to induce flows of capital between buyer and seller. It is acknowledged that the stock market does not operate autonomously, but rather influenced by other economic factors. As such, some studies measuring the relationship between macroeconomic variables and the aggregate stock market share prices exists (Ajayi & Olaniyan, 2016; Enisan & Olufisayo, 2009; Mangani, 2009; Ali, Abdelnabi & Iqbal, 2016).

However, the study aims to investigate the stock returns in the JSE as it is through returns that investors or investment bankers yields profits in a particular security. An article by Crowe & DiLallo (2017) advances that the stock market serves two very important purposes. The first is to provide capital to companies that they can use to fund and expand their businesses. To avoid incurring debt and paying interest charges on debt from borrowing, companies offer stock shares instead, for capital needed for expansion.

The secondary purpose the stock market serves is to give investors, those who purchase stocks, the opportunity to share in the profits of publicly-traded companies. Investors can profit from stock buying in one of two ways. Some stocks pay regular dividends (a given amount of money per share of stock someone owns). The other way investors can profit from buying stocks is by selling their stock for a profit if the stock price increases from their purchase price (Crowe & DiLallo, 2017). Henceforth, the study is concerned with the second option through which investors may profit from holding a particular stock in the JSE market. The determinants of stock market returns are an important issue in financial economics; literature has tried for long to find factors that explain the returns of securities (Ramos & Veiga, 2011).

The study does not focus on the overall JSE indices, but rather isolate one stock of interest. It has been argued that a sectoral approach is better for both investors as well as regulators in understanding the risk return relationship (Butt, Rehman, Khan & Safwan, 2010). Therefore, the study explores the oil and gas industry as a sector in the stock market and investigate its stock returns. This sector is given an attentive study because it is earmarked by the government as a special economic zone through its industrial action plan for investment. The proposed macroeconomic variables which may serve as economic risk exposure dictated by literature are Brent crude oil price, the Rand/Dollar exchange rate, broad money supply (M3) and the gold price (Zaighum, 2014; Ouma & Muriu, 2014; Armad, Umar & Dayabu., 2015).

Oil is the primary element in the oil & gas industry; as such crude oil price is expected to have a direct influence or impact in this sector, and may influence the market returns. The period from February 2011 to August 2014 saw an explosive hike in oil prices hovering between $103.44 $104.84 to US dollars per barrel (INETBfa, 2017). On the opposite ends, January to December of 2015 prices halved, averaging between $50.14 and $39.45 US dollars (INETBfa, 2017). These two periods reflect periods of oil price shock and price stability consecutively. Production costs of firms is said to be influenced by increase or decrease in oil prices, thereby, increasing or decreasing firm's revenue, which then leads to volatility of oil & gas sector's stock returns (Saeed, 2012).

The majority of South Africa's crude oil is supplied by three countries, namely Saudi Arabia, Nigeria and Angola which supply 89% of South Africa's total crude imports (NERSA, 2017). To this effect the USD/ZAR exchange rate plays a critical role, as depreciation or appreciation of the Rand adds to the cost of purchase. Kemda & Huang (2015) advances that volatility and performance of exchange rates are strongly linked to its financial stability on a macro-economic scale; exerting a significant impact on asset prices and firm value. The 2008 recession, mortgage bond crises, caused by mistrust within the banking community through lending misconduct saw instability in the markets. In this period the Rand peaking at R11.86 and later lowered to R8 per dollar in 2009 (Ouma & Muriu, 2014).

Under supervision or control of the South African Reserve Bank (SARB) money supply is an intricate element of the economy as it affects its activities. It is argued that movements in aggregate indices of common stock prices can be predicted from prior changes in the money supply (Auerbach, 1976). Research conducted using developed countries data made interesting conclusion that money growth affects stock prices undesirably (Osamwonyi & Evbayiro-Osagie, 2012) However, since portfolio manager, risk managers and the likes often deal with individual equities, it becomes imperative to include money supply in the stock returns relationship.

The gold mining industry has received a special focus in South Africa and well documented because of its revenue generation, in particular through its rather higher gold prices, which is priced in US dollar denomination. The gold price affects the economy in several ways, in particular: as a stimulus to certain industries through demand for products to be used on the mines, isolated as a macroeconomic variable due to the fact that its determination is largely divorced from other domestic economic variables (Van Rensburg, 1995).

1.2 STATEMENT OF THE PROBLEM

The Johannesburg Stock Exchange (JSE) has a number of listed companies which belong to the oil and gas Sector. However, many of South Africa's crude oil requirements are met through the importation of crude oil. Thus, the extent of the impact of crude oil prices on oil and gas stocks listed on the JSE is an empirical question that warrants a formal study. It is, however, anticipated that macroeconomic factors other than crude oil prices would have an effect on oil and gas stock listed on the JSE (JSE, 2015). The effect of changes in macroeconomic variables on share prices is referred to as economic risk exposure as defined in the current study.

The 2012 Marikana massacre had an impact on the Rand reaching a three year high to R9 per dollar. As of February 2016 USD/ZAR exchange rate was at R16.56 responding to the cabinet reshuffling (Chinzara, 2011). This implies that instability in financial markets could spill-over to investment activities especially in the stock market. Hence it was interesting to find out if some factors such as exchange rate, gold prices money supply and Brent crude oil prices can influence stock returns.

1.3 RESEARCH QUESTIONS

- Do changes in economic risk exposure factors (exchange rate, gold prices money supply and Brent crude oil prices) have an effect on the oil & gas industry stock market returns in South Africa?
- How do the economic risk factors affect the stock market returns in the long-run?

- Is there pairwise causality between the macroeconomic factors and Oil & Gas stocks listed on the JSE?

1.4 RESEARCH AIM

The aim of the study is to investigate how economic risk exposure measured by Brent crude oil prices, R/USD exchange rate, money supply and gold prices can influence oil & gas stock returns listed on the JSE in the period 2007-2015.

1.5 OBJECTIVES

The objectives of the study are as follows:

- To find estimates of economic risk exposure (exchange rate, gold prices money supply and Brent crude oil prices) on stock market returns using a GARCH model.
- To find if there is a long run relationship in the series using the cointegration method of Johansen.
- Investigate causality between stock returns and macroeconomic risk factors using pairwise causality.

1.6 DEFINITION OF CONCEPTS

- **Stock market returns**: Are the returns that the investors generate out of the stock market. This return could be in the form of profit through trading or in the form of dividends given by the company to its shareholders from time-to-time (JSE, 2017).
- **Share prices:** The cost of purchasing a security on an exchange, and may be affected by volatility in the market, current economic conditions and popularity of the company (JSE, 2017).
- **Exchange rate:** Exchange rate defined as the value of a country's currency expressed in terms of another country's currency (Kemda & Huang, 2015).
- **Broad money supply (M3):** A comprehensive measure of money, a total supply of money in circulation in an economy for a given time which includes all long-term deposits of the domestic private sector with monetary institutions (Mohr & Fourie, 2008).
- **Economic risk exposure:** Economic exposure is the risk that a company's cash flow, foreign investments, and earnings may suffer as a result of fluctuating foreign currency exchange rates (Kemda & Huang, 2015). In this study economic risk

exposure is measured by exchange rate, gold prices, money supply and Brent crude oil prices.

1.7 SIGNIFICANCE OF THE STUDY

The study aims to study the economic risk exposure in the oil and gas industry stock returns. According to the author the study carries weight in that relevant sector or market specific literature is lacking, with a few studies carried out (Ramos and Veiga, 2011; Ajayi & Olaniyan, 2016; Mangani, 2009). This is so because most literature studied the aggregate stock market prices, all share index, against macroeconomic variables (Tripathi & Kumar, 2015; West & Macfarlane, 2013; Hsing, 2014; Szczygielski & Chipeta, 2015; Mongale & Eita, 2014; Ali, Abdelnabi, Iqbal, Weni & Omer, 2015; Ntshangase, Mingiri & Makhetha, 2016; Van Rensburg, 2000; Mlambo, Maredza & Sibanda, 2013; Moolman & Du Toit, 2005; Chinzara, 2011)

This study will add to literature because more sector specific study ensures that components of the economy may be exposed as relevant and significant economic indicators for the oil and gas industry's stock returns. More relevance to the study could inform asset managers and portfolio managers on the sector analysis regarding equities. The study is given stimulus by the work of Ramos and Veiga (2011) who studied risk factors in oil and gas industry returns, international evidence of 34 countries including South Africa. That study included three risk factors (oil prices, interest rate and currency), while this study will add a commodity variable in gold price, of which South Africa is a leading producer. Secondly, the findings were more detailed for developed countries like the United States of America, Japan, Denmark, Canada and the United Kingdom. Hence, this study aims to study the South African market, to this effect, in the author's knowledge no previous work exists for oil and gas sector returns.

Ajayi & Olaniyan (2016) also studied the dynamic relations between macroeconomic variables and stock prices for U.K and RSA employing the VECM model. Off concerning is that long-run relationship between macroeconomic variables and stock prices was not found in South Africa, henceforth the study seeks to revisit and also use a breed of methods. For instance, an application of the GARCH model is also used in the study. It is argued in this study that there exists a relationship among volatility of stock returns and volatility of economic factors in emerging market of South Africa.

The structure of the dissertation going forward will be as follows, the next chapter, chapter two, is relevant theories and literature review, followed by chapter three, Oil & Gas stock returns and economic factors overview, chapter four presents the study methodology, thereafter chapter five present the findings, and lastly chapter six conclude the study accordingly.

1.8 ETHICAL CONSIDERATIONS

I declare that protocols and ethics were followed, all relevant references are acknowledged. This dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter seeks to put forward the underlying theories capturing the topic under discussion. Thorough and detailed theories are a guide to understand and anticipate the expected findings, and also placing in literature, which is the empirical finding of previous works across different countries which serve as the guiding and anticipated results. The procedure is as follows, firstly, the principle framework is outlined to give perspective of guiding theories. Afterwards, previous literature of the understudy is carried out before presenting an overview of all the macroeconomic variables and the oil and gas share prices movements over the stated period, and lastly a summation of the chapter.

2.2 THEORETICAL FRAMEWORK

The relationship between macroeconomic variables and stock market returns is evident in literature and relevant theories to this effect include arbitrage pricing theory (APT) and Efficiency Market Hypothesis (EMH) which are utilised in the study to relate the relationship between economic risk exposure and stock returns in the oil and gas industry.

2.2.1 Arbitrage pricing theory

Ross (1976) hypothesizes the Arbitrage pricing theory (APT) where various economic risk factors may explain stock market returns. This theory espouses an idea that stock market returns may be impacted by and explained through risk elements of micro and macroeconomic fundamentals. It is acknowledged that stock returns remain exposed to systematic economic news, priced accordingly in relation to economic risk exposures which require accomplished and simple intuitive financial theory to measure the economic exposures (Ouma & Muriu, 2014).

The relevance of APT model in the study is captured by the fact that all economic risk exposures under investigation in the oil and gas sector stock returns are as espoused in the South African economic news. It is a question of whether the risks may be significant or insignificant given the measured level of risk association. APT provides a more realistic explanation to the variations in stock prices as it allows for a wider selection of various factors that determine stock return; it is for that reason, APT has become a significant theory in explaining the impact of macroeconomic variables on stock returns (Nordin, Nordin & Ismail, 2014.).

This theory is further given relevance because of the underlying assumptions. The assumptions of the APT are as follows (Wei, 1988):

- All investors exhibit homogeneous expectations that the stochastic properties of capital assets return are consistent with a linear structure of K factors.
- Either there are no arbitrage opportunities in the capital markets or the capital markets are in competitive equilibrium.
- The number of securities in the economy is either infinite or so large that the theory of large numbers are applied.
- The APT hold in both the multi-period and single period cases.

The last assumption point puts forward the relevance of the study in applying the APT, even giving reason to intuitively assume the factor structure. The APT simply implies that there is a relationship between security returns and a limited number of factors (Van Horne, 1989).

2.2.2 Efficiency market hypothesis

The efficient market hypothesis is based on the assumption that prices of securities in financial markets fully reflect all available information, which views expectations of future prices as equal to optimal forecasts using all currently available information (Mishikin & Serletis, 2011). Hence, stock prices determination quickly adjusts as information of relevant economic or sector indicators become available. Nordin et al (2014) puts forward three forms of market hypothesis:

- Weak form, were market efficiency asserts that asset prices integrate all relevant past information.
- The semi-strong form, which indicates that asset prices do not just reflect past information, but also other information available to the public.
- Finally, the strong form of market efficiency, which implies that asset prices do not just reflect past and public information, but also private information particularly those specifically related to the company.

Of the three views, the stronger form of market efficiency has received much attention and subject of much study in the financial markets, because it provides the basis to asses which indicators offer much information to asset pricing. This stronger view of market efficiency has several important implications in the academic field of finance (Mishikin & Serletis, 2011):

- First, it implies that in an efficient capital market, one investment is as good as any other because the securities prices are correct.
- Second, it implies that a security s price reflects all available information about the intrinsic value of the security.
- Third, it implies that security prices can be used by managers of both financial and nonfinancial firms to assess their cost of capital (cost of financing their investments) accurately and hence that security prices can be used to help them make the correct decisions about whether a specific investment is worth making or not.

The equilibrium returns of securities is influenced by numerous risk factors, as efficient market hypothesis views expectations of future prices as equal to optimal forecasts using all currently available information. This Makes the efficient market hypothesis a sort after theory in the academic field of finance, and much more relevant to the study at hand.

2.3 **EMPIRICAL LITERATURE**

Quite a number of studies have been carried out in developed economies with regard to macroeconomic variables and stock market prices or returns relationship. However, sector specific analysis to this regard is minimal across all economies; as such background literature will encompass aggregate stock market indices and sector specific stock returns works thereof. To this regard a breed of related literature covering volatility relationship, long-run relationship and causality effects within the economic factor or macroeconomic variable and stock market returns relation is presented.

2.3.1 South African literature

An investigation of the effects of discount rate and gold price changes on individual stocks traded on the JSE Securities Exchange of South Africa employing a GARCH framework (Mangani, 2009). The empirical results found that gold price changes largely influenced stock return volatility. Gupta and Modise (2013) explored the link in macroeconomic variables and South African stock return predictability and data covers the in-sample period of 1990:01 to 1996:12 and the out-of sample period of 1997:01 to 2010:06. With crude oil prices, money supply (M1 and M3) and industrial production growth rate, the results suggests that macroeconomic and financial variables do not seem to contain much information in predicting South African stock return in a linear predictive regression framework. Ramos and Veiga (2011) examined risk factor associated with oil and gas industry encompassing developed and emerging economies including South Africa. The results revealed that oil and gas sector in developed countries responds more strongly to oil price changes than in emerging markets.

Ajayi & Olaniyan (2016) studied the dynamic relations between macroeconomic variables and stock prices for United Kingdom (U.K) and RSA employing the VECM model spanning from March 2000 to December 2009. The results concluded that no long-run relationship exists between macroeconomic variables, inflation and industrial production, for South Africa. By applying Granger causality test estimates suggests that changes in industrial production are better explained by South Africa's past values and past performance. Following on Tripathi & Kumar (2015) BRICS study, these are South African results; stock returns have significant negative relationship with current inflation, current exchange rate, long run inflation and long run interest rate. West & Macfarlane (2013) addressed the empirical question of whether macroeconomic variables drive future stock market returns in South Africa; data was examined over a 45 year period from 1965 to 2010 through the use of Johansen multivariate cointegration, Granger causality and innovation accounting. Findings as per the VECM model estimates reveal that inflation and money supply have a positive relationship with the 'all share stock index' over the long run. However, inflation is not significant. A negative relationship was found for the South African 10 year Government Bond Yield (which is used as a measure of the interest rate), the rand dollar exchange rate and GDP.

Hsing (2014) examines the effects of selected macroeconomic variables on the stock market index in South Africa; the exponential GARCH (Nelson, 1991) model is applied. Findings show that the stock market index is positively influenced by the growth rate of real GDP, the ratio of the money supply to GDP and the U.S. stock market index and negatively affected by the ratio of the government deficit to GDP, the domestic real interest rate, the nominal effective exchange rate, the domestic inflation rate, and the U.S. government bond yield.

Szczygielski & Chipeta (2015) employs a multifactor model motivated by the Arbitrage Pricing Theory (APT) to describe the time series behaviour of the South African stock market as represented by the JSE All-Share Index of monthly returns on the FTSE/JSE All-Share Index (henceforth JSE All-Share Index) over the July 1995 to March 2011 period. Results through the least square (LS) method reflect that Inflation and inflation expectations have a negative impact on the South African stock market whereas real activity, changes in the money supply, oil price fluctuations, the exchange rate and cyclical variations have a positive impact on the South African stock market. However, Szczygielski & Chipeta (2015) advanced that the (ARCH) and (GARCH) model framework is found to be a more appropriate econometric framework relative to the Least Squares framework (LS) for models of the return generating process of South African stock returns. Hence, selective results are as follows, the relationship between returns and unexpected changes in oil prices is positive and statistically significant; the USD/ZAR exchange rate has a positive and significant impact on all share returns; and lastly, unexpected changes in the broad money supply (monetary aggregate), M3 have a statistically significant and positive impact on South African stock returns.

Mongale & Eita (2014) investigated the effects of the commodity prices and selected macroeconomic variables on stock market performance. The paper uses quarterly time series data and the estimation covers the period 1994 to 2013 using Engle-Granger two steps econometric technique. The findings show that an increase in commodity prices, such as gold prices, is associated with an increase in stock market performance and there is a positive association between stock market and macroeconomic such as money supply and exchange rate in South Africa. Further similar studies examined the long-term equilibrium between South Africa's stock index and selected macroeconomic variables using VECM technique (Ali. et al, 2015). The outcome of the VECM reveals that exchange rate had a positive and significant relationship, while money supply had e negative but insignificant relationship with South African stock index.

An empirical analysis of the relationship between the stock market and macroeconomic policy variables in South African for the period from 1994 to 2012 employing the Johansen cointegration test and the restricted VAR model were employed to analyse the relationship between the variables of interest (Ntshangase. et al, 2016). The results show that changes in money supply, interest rate, inflation, exchange rate and government expenditure are transmitted into the stock market; with all variables having a negative and insignificant long-term relationship with all share index accept inflation had a positive relation. Van Rensburg (2000) adopted the Chen. Roll & Ross pre-specified variable approach to priced arbitrage pricing theory factor (APT) identification on the Johannesburg Stock Exchange (JSE) over the period 1985 to 1995. An assessment of the effects of currency volatility on the Johannesburg Stock Exchange, the GARCH model was used in establishing the relationship between exchange rate volatility and stock market performance. The study employed monthly South African data for the period 2000 –2010 (Mlambo. et al, 2013). A very weak relationship between currency volatility and the stock market was confirmed, furthermore, since the South African stock market is not really exposed to the negative effects of currency volatility, government can use exchange rate as a policy tool to attract foreign portfolio investment.

Moolman & Du Toit (2005) developed a structural, theoretical model of the South Africa stock market using cointegration and error correlation model with quarterly data from 1978 to 2000. The results revealed cointegration between the JSE overall index and macroeconomic variables, off relevant, the Rand/USDollar exchange rate and gold prices. Ali, et al (2016) Investigates the impact of certain economic variables described in a previous section on the stock market behaviour of South Africa using monthly data for the period between January 1998 and August 2010. To achieve this objective, the study employs time series techniques or vector Auto-regression (VAR) framework. Upon testing for co-integration, long run structural equation modelling (LRSM) and VECM, the results indicate that industrial production is the most important determinant of stock market prices. This suggests that South Africa's stock market is highly sensitive to the country's industrial production. Money supply, inflation, and exchange rates are other determinants of South Africa's stock index but to a lesser extent than industrial production. The study found that the macroeconomic variables comprising industrial production, inflation, money supply, and exchange rate are cointegrated on the long run with stock market prices.

Daggash & Abrahams (2017) had a study focus on the effects of exchange rate (included crude oil prices) on the performance of the Nigerian and South African stock markets or equities utilising a 5-day weekly data from January 2013 to December 2016, were obtained through the ARCH/GARCH estimation. On the South African findings, exchange rate had a negative but insignificant relationship, while crude oil had a positive and significant relationship. Ocran (2010) sort to examine the dynamic causal relations between the two stock prices of the US, South Africa and the rand/US$ exchange rate by employing a mix breed of techniques, the Granger causality, impulse response and variance decomposition. It was identified that there is a bi-directional causality from the Standard & Poor's 500 stock price index to the rand/US$ exchange rate in the Granger sense, and domestically it was empirical that exchange rates do not Granger cause SA'stock prices, and vice versa. The exchange rate shocks have little or no effect on the South African stock price.

A 'commodity currency' hypothesis of the Rand, that is, an advance that the currency moves in line with commodity prices, and analyses the associated causality using nominal data between 1996 and 2010 (Schaling, Ndlovu & Alagidede, 2014). While cointegration was absent, the two variables are negatively related, with strong and significant causality running from commodity prices to the exchange rate and not vice versa, implying exogeneity in the determination of commodity prices with respect to the nominal exchange rate. Chinzara (2011) sort findings on macroeconomic uncertainty and stock market volatility for South Africa. The results were that stock market volatility is significantly affected by macroeconomic uncertainty, that financial crises raise stock market volatility, and that volatilities in exchange rates and short-term interest rates are the most influential variables in affecting stock market volatility whereas volatilities in oil prices, gold prices and inflation play minor roles in affecting stock market volatility.

2.3.2 Literature in developed economies

A size effect and macroeconomics factors in New York stock exchange returns by employing Vector Error correlation Model (VECM) was carried out (Shubita & Al-Sharkas, 2010). It was found that inflation and interest rates had an inverse relationship to market stock returns in United States of America (USA). Contrary to that study, a recent similar paper found that consumer price index, which is often used as proxy for inflation was stated as insignificant to U.S stock returns. While gross domestic product, industrial production index, long-term interest rates had statistical significance to stock returns (Jareno & Negrut, 2016). Park & Ratti (2008) examined oil price shocks and stock markets in the U.S and 13 Europeans countries over 1986:1-2005:12. The findings in retrospect to European countries suggest that oil price shocks contribute variably and depress stock market returns significantly. Oil price shocks had a greater impact than interest rates in stock market return variability. Ajayi & Olaniyan (2016) studied the dynamic relations between macroeconomic variables and stock prices for United Kingdom (U.K) and South Africa employing the VECM model spanning from March 2000 to December 2009. The U.K results reflect that stock prices are positively related to industrial production, however, had a negative relationship with inflation.

Masuduzzaman (2012) investigated the long-term relationship and the short-term dynamics among macroeconomics fundamentals and stock returns of Germany and the United Kingdom, employing Johanssen-cointegration and error correction model. It was found that there is a long-run causal relationship and short-term dynamics for Germany and U.K stock market returns and certain macroeconomic variables, which are, consumer price index, interest rate, exchange rate, money supply and industrial production. An impact of several macroeconomic variables on the Dow Jones Sustainability and Dow Jones Wilshire 5000 indexes, using a GARCH model and monthly data for the period January, 2000 to January, 2008 was examined (Sariannidis, Giannarakis, Litinas & Konteos, 2010). The results show that changes in returns of crude oil prices affect negatively the U.S. stock market; the exchange rate volatility affects negatively the returns of the U.S. stock market.

Hsieh (2013) examines the effects of selected macroeconomic variables on the New Zealand stock market. The exponential GARCH (Nelson, 1991) model is applied. It finds that New Zealand's stock market index is positively influenced by real GDP and the world stock market index and negatively affected by the ratio of the government debt to GDP, the domestic real interest rate, the nominal NZD/USD exchange rate and the domestic expected inflation rate. Dhaoui & Khraief (2014) examines empirically whether oil price shocks impact stock market returns using monthly data for eight developed countries (US, Switzerland, France, Canada, UK, Australia, Japan and Singapore) from January 1991 to September 2013 applying the EGARCH model. Findings are as follows, At the 5% significance level, the oil price exerts significant effect on returns for three countries which are the US, Switzerland and Canada, and on the volatility for four countries which are the US, Canada, Japan and Singapore. Therefore, the effect on both stock returns and volatility at 5% level is observed in the cases of US and Canada. At the 10% level, oil price presents significant effect in four countries: France, Australia, UK and Japan. On volatility, only the Switzerland has a significant effect of oil price.

An analysis of long-term equilibrium relationships between the Singapore stock index and selected macroeconomic variables, as well as among stock indices of Singapore, Japan, and the United States was investigated by (Maysami & Koh, 2009). Changes in Singapore's stock market levels do form a cointegrating relationship with changes in price levels, money supply, short- and long-term interest rates, and exchange rates. While changes in interest and exchange rates contribute significantly to the cointegrating relationship, those in price levels and money supply do not.

A test for the presence of informational inefficiencies on stock markets of selected CEE countries (Croatia, Czech Republic, Hungary, Poland and Slovenia) analysing the relationship between stock market indices and macroeconomic variables, using monthly data for the period from January 1998 to January 2010.3 employing Johansen cointegration method (Barbic & Condic-Jurkic, 2011). Results established a long-run relationship between stock market indices and macroeconomic variables, especially in case of Poland and Czech Republic. The results of Granger (non) causality reveal that there is no causal linkage between any macroeconomic variable and stock market index in Croatia, Hungary and Poland; money supply and foreign exchange lead stock index in Czech Republic, while inflation rate and money market interest rate lead Slovene stock index; none of stock market indices might be used as a leading indicator of inflation rate; lastly, stock market index leads money market interest rate in Hungary and Czech Republic, foreign exchange reserves in Slovenia and money supply in Poland.

Within the framework of a standard discounted value model an examination whether a number of macroeconomic variables influence stock prices in the US and Japan was reviewed. A cointegration analysis is applied in order to model the long term relationship between industrial production, the consumer price index, money supply, long term interest rates and stock prices in the US and Japan (Humpe & Macmillan, 2007). For the US the data are consistent with a single cointegrating vector, where stock prices are positively related to industrial production and negatively related to both the consumer price index and a long term interest rate; and an insignificant (although positive) relationship between US stock prices and the money supply. However, for the Japanese data there were two cointegrating vectors; where one vector reveals that stock prices are influenced positively by industrial production and negatively by the money supply

The impact of conventional stock market return and volatility and various macroeconomic variables (including inflation rate, short-term interest rate, the slope of the yield curve and money supply) on Islamic stock markets returns for twenty developed and emerging markets using Markov switching regression models (Bahloul, Mroua & Naifar, 2017). The empirical results for the period 2002-2014 show that both developed and emerging Islamic stock indices are influenced by conventional stock indices returns and money supply for both the low and high volatility regimes. However, the other macroeconomic variables fail to explain the dynamics of Islamic stock indices especially in the high volatility regime.

Arfaoui & Rejeb (2016) took a global perspective in examining relationships among oil, gold, US dollar and stock prices, using simultaneous equations system to identify direct and indirect linkages for the period spanning from January 1995 to October 2015. Results show significant interactions between all parties, it found negative relation between oil and stock prices but oil price is significantly and positively affected by stock markets, gold and USD. Gold price is concerned by changes in oil, USD and stock market prices but slightly depend on US oil imports and corporate default premium. The US dollar is negatively affected by stock market and significantly by oil and gold prices and also by US consumer price index. Indirect effects always exist which confirm the presence of global interdependencies and involve the financialization process of commodity markets.

Arouri & Nguyen (2010) investigates the relationships between oil price changes and sector stock market returns in Europe over the last turbulent decade, with an analysis estimation of multifactor asset pricing models to investigate the sensitivities of the sector stock returns to oil price and European market changes, and then perform the Granger causality tests to examine their causal linkages. Results confirmed the significance of oil price shocks as a factor affecting sector returns in Europe, oil and gas sector index included. Additionally, Granger causality results show that there is bidirectional causality between oil price changes with the oil and gas sector among other sectors. Morelli (2000) attempts to determine the relationship between conditional stock market volatility and conditional macroeconomic volatility based upon monthly UK data covering the period January 1967–December 1995; conditional volatility is estimated using the well-known Autoregressive Conditional Heteroscedastic (ARCH), Generalised ARCH (GARCH) models.

2.3.3 Literature in developing economies

Zaighum (2014) gave evidence in sectorial studies in an impact of macroeconomic variables on the Karachi stock market return in Pakistan. The findings revealed that CPI and money supply demonstrated a statistical significance and negative impact on all sector returns including oil and gas industry, while industrial production index (IPI) was also statistically significant, however, depicted a positive relationship for some sectors including oil and gas sector returns. A study investigation of six macroeconomic variables on the behaviour of Indian stock market for the period 2006:04 to 2013:07 by applying Granger causality was carried out (Mohanamani and Sivagnanasithi, 2014). Granger causality results revealed that whole sale prices index and industrial productivity influences the stock market to a great extent; stock market was also positively related to money supply, industrial production and whole sale prices. A Nigerian study on the relationship between macroeconomic variable and stock market development spanning the period 1970 to 2013 was carried out (Umar, 2015). It was found that found that money supply had a significant and negative influence on the stock market in the long run, while consumer price index, interest rate and oil prices had a significant and positive influence in the long-run. Recent follow on studies encompassed exchange rate and inflation as significant variables and a negative relation to the stock prices in Nigeria (Nkoro and Uko, 2016). However, a previous similar Nigerian study revealed negative exchange rate relationship but insignificant and consumer price index as proxy for inflation had a positive relation in the long run with (Osamwonyi & Evbayiro-Osagie, 2012).

Saeed (2012) examined the impact of macroeconomic variables on the stock market returns by applying the multifactor model within an Arbitrage Pricing Theory (APT) frame work. The findings revealed that out of money supply, exchange rate, industrial production index, short term interest rate and oil prices only exchange rate and oil prices have a significant impact on specific sectors like oil and gas sectors and automobile. A Bangladesh study investigated the effects of exchange rate and interest rate on stock market performance by using monthly time series data for the economy over the period of 1997 to 2010. Employing cointegration and error correlation mode the results revealed that a one percentage change increase in exchange rate and in interest rate contributes1.04% increase and 1.71 % decrease in market index respectively. A study scrutiny of the relationship between macroeconomic factors on Amman stock market exchange (ASE) returns for the period 1993:3 and 2013:9 was carried out (Al-Zararee and Ananzeh, 2014). Of the six variables understudy, consumer price index had a positive and significant impact, while real money supply had a negative significant impact on stock returns.

A Kenyan analysis on the impact of the macroeconomic variables on stock returns during the period 2003- 2013, applying the APT and Capital Asset Pricing Model (CAPM) framework for monthly data was carried out (Ouma and Muriu, 2014). Money supply and inflation were found to significantly determine stock returns while interest rate was seen as insignificant and exchange rate had a negative relation to stock returns. Money supply was seen to have a negative relationship with African stock market in a study of macroeconomic variables relationship and African stock markets employing panel cointegration analysis (Babayemi, James, Singh, Onwuka & Asare, 2013).

Jamaludin, Ismail & Manaf (2017) examined the effect of macroeconomic variables namely inflation, money supply (MS), and exchange rate (ER) on stock market returns in the three selected ASEAN countries (Singapore, Malaysia, Indonesia) by utilizing monthly data over the period of January 2005 to December 2015. The results, through panel least square regression technique, found that money supply was insignificant; exchange rate and inflation were significant with inflation carrying an inverse relationship to the stock market return. The role of macroeconomic variables on Iranian stock markets utilising a variance method covering the period 2007 to 2011 was carried out (Khodaparasti, 2014). The analysis results exposed that exchange rate and industrial index have more effect on the stock market than inflation and money supply (M1). Macro-economic indicators on stock returns effect, evidence from Kuwait stock market was studied from January 2001 to December 2010 on a monthly basis analysed using Vector autocorrelation regression (VAR) (Al-Shami & Ibrahim, 2013). The results were concluded in one month and two months breaks, and it was found that money supply, inflation and oil prices had positive relation with stock returns, while interest rate had a negative relationship with stock returns in one month.

Ahmad & Ramzan (2016) studied the Stock Market Volatility and Macroeconomic Factor Volatility for Pakistan's Karachi stock index using daily data from 2000-2014. Results show the existence of relationship among the volatility of stock market and volatility of macroeconomic factors analysed through vector auto regressive models furthermore, money supply (M2) were seen not to have a direct effect with movements in stock market, while inflation volatility measured in consumer price index proves to have significant relationship with volatility of stock returns.

An analysis of the impact of macroeconomic uncertainty on stock-price volatility in Ghana using the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model adopting a monthly frequencies from January 1991 to January 2007 (Adjasi, 2009). Empirical findings were that higher volatility in gold prices, oil prices, and money supply reduces volatility of stock prices. Zakaria & Shamsuddin (2012) examined the relationship between stock market returns volatility in Malaysia with five selected macroeconomic volatilities; GDP, inflation, exchange rate, interest rates, and money supply based on monthly data from January 2000 to June 2012 using the GARCH estimation. The result from regression analysis shows that only money supply volatility is significantly related to stock market volatility. The volatilities of macroeconomic variables as a group are not significantly related to stock market volatility.

Olweny & Omondi (2011) sought to investigate the effect of Macro-economic factors on the stock return volatility on the Nairobi Securities Exchange, Kenya using monthly time series data for a ten years period between January 2001 and December 2010 through the Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) and Threshold Generalized Conditional Heteroscedasticity (TGARCH). Results showed evidence that Foreign exchange rate, Interest rate and Inflation rate, affect stock return volatility. On foreign exchange rate, magnitude of volatility is relatively low and significant.

Nkoro & Uko (2016) investigated the relationship between exchange rate and inflation volatility and stock prices volatility in Nigeria, using time series quarterly data from 1986Q1-2012Q4. The volatilities of exchange rate and inflation in this study were calculated using standard GARCH(1,1) models. The findings of the study show that there is a negative relationship between stock market prices volatility and exchange rate and inflation volatility in Nigeria. A study was carried out to analyse how the economic instability influences stock market performance on bear and bull markets with a weekly credit default swaps, exchange rate volatility and stock market returns in Turkey for the period of 01.02.2010-17.03.2017, Markov Switching GARCH(1,1) model is used in the study (Kayalidere, Güleç & Erer 2017). Results of the analysis indicate that, both credit default swaps and exchange rate volatility negatively affect the stock market performance in bear and bull markets.

An empirical examination into the long-run and short-run equilibrium relationships between macroeconomic variables and the Malaysian stock market index (SMI) for the 1977-2011 period employing the co-integrating relationships among variables are tested using the bounds F-statistic test (Bekhet & Mugableh, 2012). Results found that the variables understudy were cointegrated, as such, there exists a long-run relationship. Moreover, exchange rate and money supply are negatively related to the Malaysian stock market indices in the long-run. However, exchange rate had a negative relationship with SMI in the short-run, while, money supply had a positive association. Gay (2008) studied the time-series relationship between stock market index prices and the macroeconomic variables of exchange rate and oil price for Brazil, Russia, India, and China (BRIC) using the Box-Jenkins ARIMA model. No significant relationship was found between respective exchange rate and oil price on the stock market index prices of either BRIC (Brazil, Russia, India and China) counties.

Tripathi & Kumar (2015) examined the relationship between macroeconomic variables (GDP, inflation, interest rate, exchange rate, money supply, and oil prices) and aggregate stock returns in BRICS (BRIC plus South Africa) markets over the period 1995-2014 using quarterly data applied Auto Regressive Distributed Lag (ARDL) model to document such a relationship for individual countries as well as for panel data. The results are as follows for individual countries, Brazil stock returns have a significant negative relationship with its lagged value, long run exchange rate and long run oil prices while it has a significant positive relationship with short run money supply and long run inflation. Russian stock returns have significant negatively relationship with past values of GDP and significant positive relationship with lagged values of money supply. Indian stock returns are negatively related with their own lagged values; lagged values of domestic interest rate and long run money supply. Neither the lagged values of Chinese stock returns, nor the present and past values of any macroeconomic variables are significant in explaining present Chinese stock returns; this is also true for long run coefficients of macroeconomic variables.

A research focus on the relationship between the development of Islamic stock market and macroeconomic variables in Malaysia, used monthly data from April 1999 to October 2007, and an estimation of Vector Auto Regression (VAR) method was applied to yield results (Hussin, Muhammad, Abu & Awang, 2012). The empirical findings were that, Islamic stock prices are co-integrated with the selected macroeconomic variables in which the stock price is related positively and significantly with industrial production index and consumer price index variables but related negatively and significantly with broad money supply and MYR variables. Meanwhile, its relation with IIR variables is found negative but insignificant. From the aspect of Granger causal relationship it is found that variables of CPI, M3 and MYR are the Granger cause for KLSI and the KLSI is the Granger cause for IPI, CPI and MYR.

Long run Relationship among Oil, Gold and Stock Prices in Pakistan was studied with examined using Jhonson and Julius Co- integration Approach and data was used from year 2002 to 2010 (Irshad, Bhatti, Qayyum & Hussain, 2013). Results cleared any existence of cointegration, no long run relationship exists among these sectors of the economy. A Study of both long-run and short-run dynamic relationships between the stock market index and the economic variables with quarterly data covering the period of 1999:1 to 2007:4 using Johansen's multivariate cointegration test techniques was investigated (Herve, Chanmali & Shen, 2011). The study identified that there is cointegration, hence long-run relationship. The Granger-causality test based on the vector autoregressive (VAR) analytical framework was employed to empirically reveal that there is strong bi-directional relationship between stock price index (SPI) and domestic interest rate (IR). Bhunia & Pakira (2014) investigates the impact of gold price and exchange rates on sensex in India for the period from January 2, 1991 to October 31, 2013 using daily data with the application of unit root test, Johansen cointegration test and Granger causality test have been designed. Results outcome reveal the existence of long-run relationship between all variables, causality shows that gold price and exchange rate granger cause each other, a bi-directional causality.

Oluseyi (2015) inquired into the link between stock market prices volatility and macroeconomic variables' volatility in Nigeria, made use of monthly data for a period of January 1990 – December 2014 and employed GARCH(1,1) models, and the relationship between stock market prices volatility and macroeconomic volatilities was examined using bi-variate and multivariate VAR Granger causality tests as well as through regression analysis. Findings are that, Volatility in exchange rate, interest rate and money supply are significant meaning that volatility in exchange rate, interest rate and money supply or outside shock influenced the volatility in stock market prices in Nigeria. Moreover, the volatility in GDP, inflation and money supply were not found to Granger-cause and not significantly related to stock market prices volatility but only volatility in interest rate and exchange rate does Granger -cause stock market prices volatility; while from the regression analysis, only interest rate volatility and exchange rate are significantly related to stock market prices volatility.

A study examination of the dependence structure between the emerging stock markets of the BRICS countries and influential global factors using the quantile regression for the period September 1997 to September 2013 was explored by (Mensi, Hammoudeh, Reboredo & Nguyen, 2014). The results for prospective countries are summed up as follows; the impact of crude oil prices on the Brazilian stock returns is positive and significant only for the intermediate quantiles, and not present for extreme quantiles. There is tail independence for Russia and India, meaning that extreme (positive or negative) oil price movements have no impact on those countries' stock returns. The positive and significant dependence between the South African stock market returns and the oil returns is evident for all quantiles, except for some quantiles. Regarding the precious metal markets, the effects of gold prices on the BRICS stock returns are positive and similar across the quantiles for the Brazilian, Indian and South African economies.

Putting the above literature on review, especially for the South African context, much analysis was done for the JSE indices as opposed to more sector specific studies. A mix breed of results were perhaps narrating opposing results. For instance, Gupta and Modise (2013) espoused that macroeconomic variables such as crude oil prices and and money supply do not contain much information to predict South African stock returns. These sentiments somewhat gave impetus to Ramos and Veiga (2011) that oil and gas sector in developed countries responds more strongly to oil price changes than in emerging markets. However, other studies encompassing volatility such as Mangi (2009) found that gold prices do largely influence stock return volatility giving credence to Mongale and Eita (2014) that increase in commodity prices has a positive association with stock market performances. More recent study by Szczygielski & Chipeta (2015) also found that oil prices, money supply (M3) and exchange rates had a positive and significant influence on South African Stock Returns. While other studies found a long-run relationship between macroeconomic variables and stock returns (Ali, et al. 2016; West & Macfariane, 2013) one study found no long-run relationship (Ajayi & Olaniyan, 2016).

2.4 SUMMARY

To sum-up this chapter, guiding theories relevant to the study at hand were the arbitrage pricing theory (APT) and the efficient market hypothesis. APT advocates an idea that stock market returns may be impacted by and explained through risk elements of micro and macroeconomic fundamentals with varying power of measuring risk and return analysis. While, efficient market hypothesis assumes that prices of securities in financial markets fully reflect all available information, which views expectations of future prices as equal to optimal forecasts using all currently available information.

A detailed breed of background literature through developed and emerging countries is aligned to understand the behaviour through time thereby assessing whether these two markets react similarly or otherwise. It was interesting to note that these markets do rather have similar reactions, for instance, oil prices were seen to positively affect stock returns of most developed and emerging economies with an inverse relationship findings far apart in some economies. Literature also gave an attentive sub-section for South African body of works regarding the understudy to anticipate expected outcome thereof. Most studies found that indeed long-run relationship does exist.

CHAPTER 3

OIL & GAS STOCK RETURNS AND ECONOMIC FACTORS OVERVIEW

3.1 INTRODUCTION

An overview of all variables in the study is presented to analyse the movements of the sector stock prices and the economic factors so as to understand the behaviour in the economy. The period from 2007 to 2015 presents a breed of events from political, social and indeed economic events. As such, it becomes an interesting undertaking to monitor the movements of the variables understudy in line with these news worthy and markets altering occurrences. Relevant to the study, a major event which caused financial catastrophe in the markets is worth mentioning. Starting in August of 2007, the United States economy was hit by the worst financial disruption since the Great depression when defaults in subprime residential mortgages led to major losses in financial institutions, producing not only numerous bank failures, but also the demise of Bear Stearns, the largest investment bank in the United States

3.2 OIL AND GAS STOCK INDEX

Figure 2.1 presents a graphical representation of the historical pattern of the oil and gas sector share prices in the Johannesburg stock exchange. The cost of purchasing a security on an exchange market may be affected by volatility in the markets, current economic conditions and popularity of the companies in this sector.

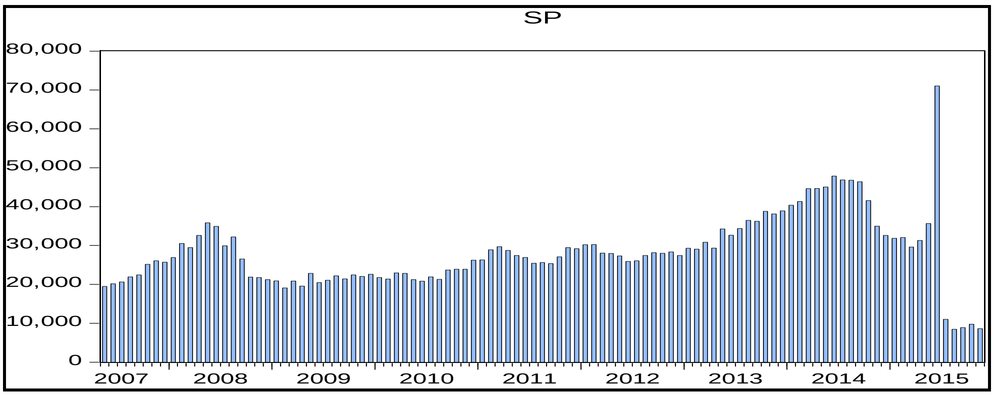

Figure 3.2.1: Oil and Gas Stocks

NOTE: Vertical line represents stock index; horizontal line represents years

Source: Author, INETBfa

A brief overview is given the oil and gas sector stocks to simply highlight its movement across the time span. However, it is essential to isolate a couple of the companies which are listed in this sector to gain an in-depth analysis of this sector, thereby answering the popularity factor of companies and how they behave in the market.

Oil & Gas stocks in the JSE faced an upward trend from the second quarter of 2007 to second quarter of 2008.. Thereafter, stocks moderately decline and sustain stabilised path of around an average of over 25, 000 until January 2011. Then, they keep a positive trend with slide fluctuations until reaching a pick of 71, 026 in mid-2015, and close off with an 88% drop to 8, 593 stocks in November 2015. One major player in this sector is SASOL limited, a South African oil and gas entity, a leader Gas-to-liquid and oil producer in this market. Figure 3.2.2 narrate its share price movements in the JSE, as one of the listed company in the oil and gas sector.

Figure 3.2.2: SASOL share prices
Source: Money web

Following summation of share price movement in relation to markets forces where highlighted (Money web, 2015)

- As a major oil producer, low oil prices are bad news for Sasol. The share price slid some 40% alongside the oil price, though it has made up some of that lost ground.
- Gas-to-liquids was looking like a major profit generator thanks to low global gas prices and the high oil prices that reigned until mid-2014 (As reflective of the July 2014 share price pick)

- SASOL share prices fell sharply in January 2015, due to the oil price falling and natural gas prices rising.
- Cheap gas and higher oil prices are going to improve Sasol's outlook dramatically.
- However, Oil is more difficult, given its sensitivity to political developments in the Middle East, recent lows seem likely to be exceptional.
- Sasol remains a solid share for any portfolio

This gives a narration of what and how do share prices move in accordance with the prevailing economic conditions. Which affect the sector stock volumes traded, as such, stock returns are sure to be altered by either a decrease or increase in share prices accordingly.

3.3. BRENT CRUDE OIL PRICES

There are compelling reasons for South Africa as a net oil importer to be concerned with energy security and/or markets implications. The country's main oil import country partners include Saudi Arabia, Iran and Nigeria among others. To this effect, South Africa is a price taker of this major energy commodity, which is US dollar denominated, priced per barrel of unrefined oil. Figure 2.3 gives the price movement of the crude oil from 01-may-2007 to 01-Nov-2015.

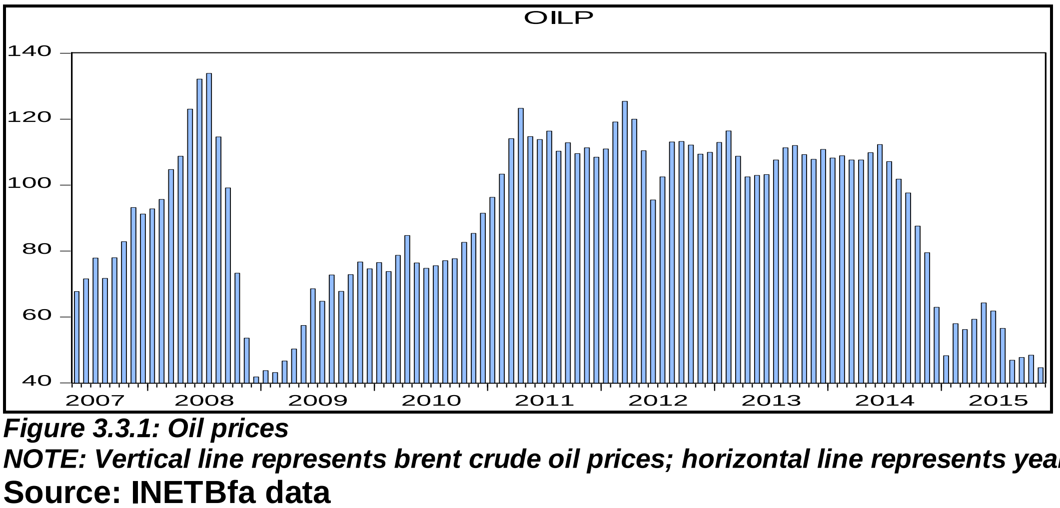

Figure 3.3.1: Oil prices
NOTE: Vertical line represents brent crude oil prices; horizontal line represents years
Source: INETBfa data

The year progressing to 2008 from 2007 sees a sharp increase in oil prices, reaching a high of $123.04 in May 2008, up from $67.69 a barrel, which is almost a doubling of oil prices in just a year. These prices continue to grow, and reach a pick of $133.86 in July of 2008. Thereafter, from $114.61 a barrel in August, oil prices take a dive and drop to $ 41.8 per barrel in the same year. The period from February of 2011 to August of 2014 sees prices stabilising, however at an average of a triple-figure prices, that is, over $100 a barrel.

The lead cause of these long sustained triple-figure prices is international oil markets experiencing structural transformation and also the political space, were Iran were facing international sanctions. Thereafter, we witness a plummeting of oil prices, reaching $44.62 a barrel in November 2015. The South African reserve bank's (2016) monetary policy review (MPR) advocate these drop in oil prices due to a tug of pricing wars between organisations of petroleum exporting countries (OPEC) and US shale producers. During 2015, members of OPEC increased oil supply, hoping to force the US shale producers out of the market. However, US producers managed to cut costs, maintaining production at lower oil prices, and this counterstrategy by both players left the world markets with an oversupply of crude oil, henceforth, the natural order is a sharp decline in oil prices. Indeed on the question of which factor causes the most oil price shock Wakeford (2006) affirms that in practice it is unlikely for demand to grow rapidly enough to cause a price shock unless it is motivated by fears of supply shortages.

Brent crude oil is a major commodity, which is also a primary product in the manufacturing process of energy companies such as Sasol and PetroSA in the oil and gas sector, for instance, as a derivative for petrol, diesel and many other use.

3.4 EXCHANGE RATE

South Africa has adopted a floating exchange rate regime, which means, the country's currency is determined by markets forces, local and foreign markets forces. Henceforth, the Rand may appreciate/depreciate against other major currencies, that is, increase/decrease in value relative to other currencies responding to prevailing market conditions. Figure 2.4 details the reaction of the USD/ZAR exchange rate to economic forces during May 2007 to November 2015.

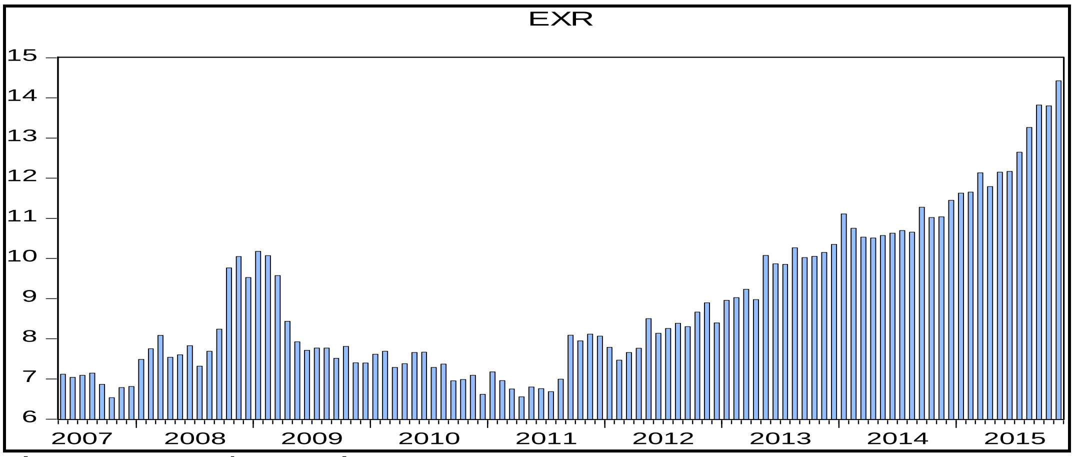

Figure 3.4.1: USD/ZAR exchange rate
NOTE: Vertical line represents R/$ exchange rate; horizontal line represents years
Source: Author, INETBfa

MPR (2016) reveal that changes in exchange rate affect Import prices, which then becomes relevant given brent crude oil as an import commodity and its associated price. The most resilient the USD/ZAR exchange rate has been during this period is the four months to December 2007, which saw the Rand appreciate to an average of R6.6/USD. Thereafter, the Rand depreciated moderately, and varies from R7.4885/USD to R8.9772/USD between April 2008 and April 2013. Post this period the Rand has a significant and red flag depreciation, with the currency getting into double digit rates, from May 2013 the rand reaches R 10.08 per dollar, thereafter averages over R10 per dollar. As of the last date of November 2015, the Rand had weakened to R14.43 per dollar. The depreciation of the Rand is said to have been persistent over the past five years, and weakened by as much as 50% against major trading partners, and 40 per cent after adjusting for inflation against the invoicing US dollar (MPR, 2016).

Furthermore, the reserve bank review states that one relevant reason for the Rand weakening is the medium-run shocks which have been driving depreciation; a demand shock as the commodity supercycle ends and capital returns to the US from riskier investment destination abroad. It is also stated by the JSE (2015) annual report that the US dollar/rand contract remains the largest contributor to volumes traded in the stock market. This becomes relevant to see the influence of the USD/ZAR exchange rate given the number of volumes traded in the oil and gas sector via share prices. The overall conclusion from different studies on the exchange rate exposure indicates that stocks respond negatively or positively to a change in the exchange rate (Muzindutsi & Niyimbanira, 2012)

And to put exchange rate in perspective there are two theoretical relationship approaches of exchange rate with stock returns (Ahmad & Ramzan, 2016)

- One is flow oriented approach by Dornbush and Fisher (1980), the flow oriented approach asserts positive relationship among exchange rate and stock returns through the trade balance of a country. It supposes that international competitiveness and trade balance of a country are affected by exchange rates and ultimately it influences the income and output. When depreciation in currency of home country occurs, it generates opportunities for local firms as their products become cheaper in international market.
- Stock oriented approach by Branson (1983) and Frankel (1983), an increase in domestic equity prices will lead an appreciation of the domestic currency because investors' demand for domestic currency increases for purchasing domestic equities. As a result, this approach insists a *negative* relation between exchange rates and stock prices.

3.5 BROAD MONEY SUPPLY

People hold money not only in hard currency, but rather try to keep the ratio of money holdings to other assets broadly constant, hence an accumulation of money and spending pattern relative to other assets will seek to restore equilibrium. The volume or amount of money in circulation may help adjust prices either positively or otherwise.

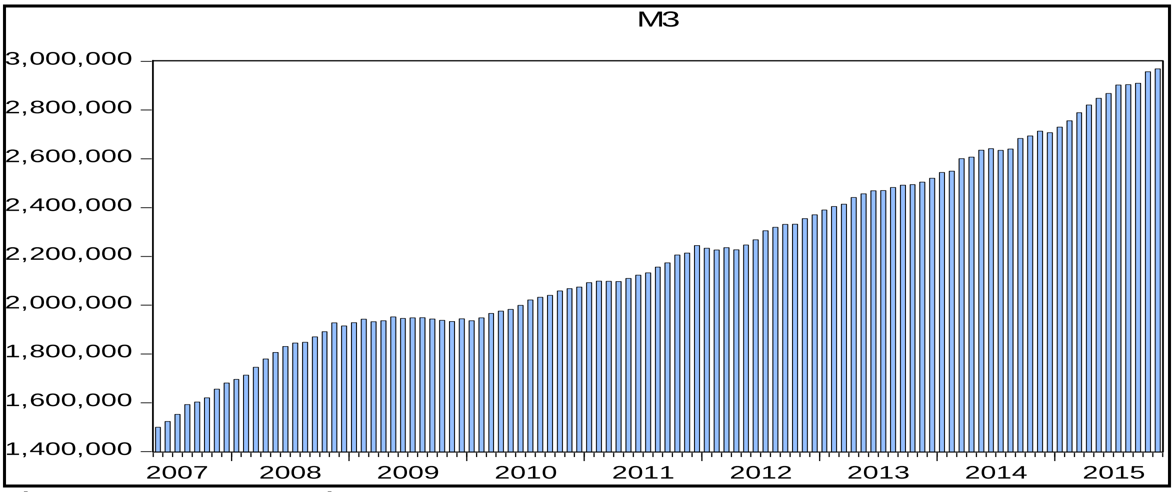

Figure 3.5.1: Money supply
NOTE: Vertical line represents broad money supply growth; horizontal line represents years
Source: Author, INETBfa

Money is quite a simple matter in the context of supply in the economy, given all sorts of economic passé from the financial recession to political instability. The supply money maintains a steady increase from 2007 all the way to 2015. Therefore, the broad money supply has an upward trend.

A look at theory to understand the implications of this asset, money, is necessary to anticipate what may occur in relation to 'stock' as an asset.

Since an asset is a piece of property, that is, a store of value such as money, bond and even stocks. The natural order of demand and supply will determine the ratio at which individuals or holders of money distribute their excess funds. According to Mishikin & Serletis (2011) facing the question of whether to buy and hold an asset or whether to buy one asset rather than another, an individual must consider the following factors:

- **Wealth**, the total resources owned by the individual, including all assets. When we find that our wealth has increased, in money terms, we have more resources available with which to purchase other assets, and so, not surprisingly, the quantity of assets we demand increases.

- **Expected return** (the return expected over the next period) on one asset relative to alternative assets. When we make a decision to buy an asset, we are influenced by what we expect the return on that asset to be.

- **Risk** (the degree of uncertainty associated with the return) on one asset relative to alternative assets.

- **Liquidity** (the ease and speed with which an asset can be turned into cash) relative to alternative assets.

This upward trend of money supply implies that, wealth in money or value terms was on the rise as individuals and players in the economy had excess funds, a note to remember is that, a decrease in interest rate by a reserve bank act as stimuli of money growth because of increased buying power. Thereby, may have diversified their portfolio of assets through stocks or any alternatives. In relation to expected return and liquidity of assets, stocks have an added advantage over other assets because stocks may yield returns on a daily and weekly basis and have an ease of liquidity over other assets like bonds. A drawback in holding stocks is risk associated with share prices, that is, uncertainty associated with returns as stock market are exposed to numerous economic, political and business practices among many other factor exposures.

Nevertheless, given the importance of money in the determination of stock prices, an important question that arises pertains to the efficiency with which stock market participants incorporate the information contained in the growth of money supply into stock prices (Habibullah, 1998). This is stated on the grounds of the ‘efficient market hypothesis’, which is based on the assumption that prices of securities in financial markets fully reflect all available information, and also advanced on the arbitrage pricing theory mentioned above.

3.6 GOLD PRICES

The country has been proven to possess a number of precious metals and well endowed. South Africa is the fifth largest producer of gold, and is more exposed than any other country to slumps in the gold price because its deep level mines are the highest cost producers in the world. This precious commodity has been treated as an independent key economic factor, and its pricing has consequently been internationally determined, US dollar denominated. Gold is included in the study largely because it is considered by investors, risk managers and the likes as a safe haven, thus, plays a critical and unique role as a store of value in times of political and economic uncertainties.

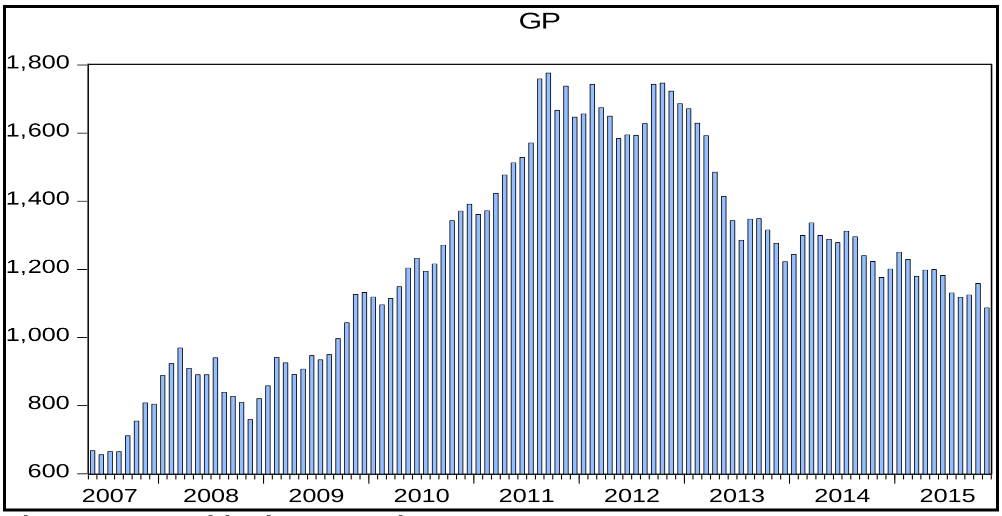

Figure 3.6.1: Gold prices growth
NOTE: Vertical line represents gold prices in US Dollars; horizontal line represents years
Source: Author, INETBfa

The gold price seems to leave up to expectations, in that from the end of the 2007 first quarter, prices reflect a positive trending pattern, moving from $667.44 in 2007 to $996.06 in the third quarter of 2009. As of the last quarter of 2015 prices closed off at $1087.05 and the highest price pick was $1776.25 in the third quarter of 2011.

Gold is seen to have a healthy performance across time regardless of prevailing state of the countries in those times. For instance, the period 2008 to 2014 the JSE is said to have been negatively affected by the United states' recession caused by the property markets. Gold commodity seems to have reacted amidst the 2012 Marikana massacre, which caused quite a disturbance in the mining sector. This positive trend is attributed to high global liquidity which continued to support the gold price, which increased by 6.4 per cent during 2012 (SARB budget review, 2013).

It stands to reason that it could be that the simple law of supply and demand of economics could be the most significant determinant of gold prices. The reserve bank review (2017) sheds light by stating that outlook for emerging markets is more positive, in part driven by the recovery in the advanced economies and stronger demand in China. Firmer commodity prices have also helped, but an oversupply of some commodities could limit gains.

Though South Africa is a major leading world producer of gold, the dollar denominated price means that currency movements may alter the cost structure of this precious metal in Rand terms. The depreciation and appreciation of the Rand against the dollar, a weaker Rand implies that the cost of purchasing gold is higher for local buyers and vice versa.

3.7 SUMMARY

To sum-up the sector share prices and macroeconomic variables espoused as economic risk exposure were discussed by tracing their movements in the economy and markets, thereby understanding their trajectories given prevailing economic conditions. Of the four economic factors, exchange rate appears to be the most sensitive to markets and prevailing current economic condition. While oil prices are open to manipulation by industry players or producers of brent crude oil, however, not negating the impact of unexpected demand growth from emerging economies also the most prominent reason for oil price increases.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

The study seeks to investigate economic risk exposure in stock market returns in the oil and gas sector guided by a quantitative research methodology, which will help achieve the set aim and objectives as outlined in chapter one. Henceforth, the adopted qualitative method will help in addressing the economic risk exposure in stock market returns for the oil and gas sector in South Africa. This section proceeds with the following sub-sections: model specifications, data source and estimation techniques before summing up this chapter.

4.2 DATA

The study employs secondary monthly data spanning the period 2007/05/3 to 2015/11/30. The oil and gas share prices, brent crude oil prices and exchange rate data were collected from InetBFA, while money supply and gold prices were collected from the South African reserve bank. The period is chosen because it include notable economic or financial crises

4.3 MODEL SPECIFICATION

This study will evaluate the economic risk exposure in the oil and gas sector's stock market returns in South Africa for the period 2007/05/30 to 2015/11/30 where oil and gas stock returns is a function of the macroeconomic variables indicating economic risk exposure. Hence,

$$SP_t = f(OILP_t, EXR_t, M3_t, GP_t) \qquad (4.1)$$

The general empirical model for oil and gas stock returns is specified as follows:

$$OilGas_t = \beta_0 + \beta_1 OILP_t + \beta_2 EXR_t + \beta_3 M3_t + \beta_4 GP + \varepsilon_t \qquad (4.2)$$

Where, 'OilGas' denotes the sector 's Stock Returns (SR), 'OILP' denotes change in Brent crude oil prices, 'EXR' denotes change in exchange rate, M3 denotes a change in money supply and GP denotes a change in gold prices. The dependant variable, stock returns (OilGas) is attained as continuously compounding returns, denoted by the following equation. This form of data transformation, computing returns is advocated by Brooks (2008).

$$SR_t = 100\% \times \ln(Index_t \, / \, Index_{t-1}) \qquad (4.3)$$

The independent variables are measured in the following manner:

- Brent crude oil prices (OILP) is converted to measure change on a month on month bases as the log of oil prices (LOILP), which is also calculated as $DLNOILP_t = (OILP_t/OILP_{t-1})$,
- The USD/ZAR exchange rate is also transformed to measure change on a month on month bases as the log of exchange rate, which is also calculated as $DLEXR_t = (EXR_t/EXR_{t-1})$
- Money supply (M3) is converted to measure change on a month on month bases as the log of money supply (LM3), which is also calculated as $DLM3_t = (M3_t{=}M3_{t-1})$
- Gold prices are also converted to measure change on a month on month bases as the log of gold prices (LGP), which is also calculated as $DLGP_t = (GP_t/GP_{t-1})$.

This form of data transformation is consistent with Bekhet & Mugableh (2012) who reasons that to stabilize the variables variances and to remove the seasonality; the variables are transformed into natural logarithmic.

4.4 HYPOTHESIS

H_0*: Changes in economic risk exposures have no effect on returns of Oil and Gas stocks listed on the JSE*

H_1*: Changes in economic risk exposures have an effect on returns of Oil and Gas stocks listed on the JSE.*

4.5 ESTIMATION TECHNIQUES

In determining the economic risk exposure in stock market returns the GARCH model is employed to measure volatility. Volatility, as measured by the standard deviation or variance of returns, is often used as a crude measure of the total risk of financial assets (Brook, 2002). While determining the long-run relationship between the variables in the study, the Johansen cointegration (1991) is employed. Furthermore, investigate causality of variables is established through the Granger (1988) causality test. However, a methodological process to be carried out, thus validating the empirical results will be as follows: unit root tests, GARCH model, Johansen cointegration, Granger causality followed by diagnostic test and stability test, the last complementing techniques are impulse response function and variance decomposition tests.

4.5.1 Stationarity/Unit root test

The first task to be carried out when dealing with time series is unit root testing to establish stationarity, the order of integration, thereby avoiding spurious results. Unit root testing determines the properties of the variables since they are macro-economic variables of a time series in nature. Hence, this test will detect the influence of time causing the variables to have a consistent and trending pattern. (Gujarati, 2004) Suggests the following, regarding macro-variables:

- Firstly, the motive is that economic theory suggests that certain variables should be integrated a random walk or a martingale process
- Secondly, and the most common, motive is to investigate the properties prior to the construction of an econometric model because most time series data are non-stationary at levels.

For this purpose, the study will employ the modified Dickey Fuller test to determine the order of integration, that is, the Augmented Dickey Fuller test (ADF). In testing for unit root for OilGas (SR), the ADF test is employed to test the null hypothesis of the coefficient of lagged OilGas (SR) is zero, that is, there is a unit root. Attari &Safdah (2013) affirm that ADF is mostly used, because it contains extra lags for the dependent variable to remove serial autocorrelation. The coefficient of lagged OilGas (SR) being less than zero is the alternative hypothesis, that is, no unit root. Formally, the null hypothesis is written as, $H_0 : \beta = 0$ and the alternative as, $H_1 : \beta < 0$ centred on the ensuing equation:

$$\Delta OilGas_t = \alpha + \beta OilGas_{t-1} + \sum_{j=1}^{p} \delta_i \Delta OilGas_{t-1} + \varepsilon_t \quad (4.4)$$

In the same respect ADF test will follow for lagged OILP, the null hypothesis and alternative hypothesis will be as follows, $H_0 : \lambda = 0$ and $H_1 : \lambda < 0$, formulated on the following equation:

$$\Delta lOILP_t = \sigma + \lambda lOILP_{t-1} + \sum_{j=1}^{q} \chi_t lOILP_{t-1} + \varepsilon_t \tag{4.5}$$

Following the same sequence ADF will test lagged EXR, the null hypothesis and alternative hypothesis are as follows, $H_0 : \phi = 0$ and $H_1 : \phi < 0$, based on the following equation:

$$\Delta EXR = \eta + \varphi EXR_{t-1} + \sum_{j=1}^{q} \gamma_t EXR_{t-1} + \varepsilon_t \tag{4.6}$$

The ADF will test the lagged M3 the null hypothesis and alternative hypothesis are as follows, $H_0 : \varpi = 0$ and $H_1 : \varpi < 0$, based on the following equation:

$$\Delta lM3_t = \varpi + \theta lM3_{t-1} + \sum_{j=1}^{q} \rho_t lM3_{t-1} + \varepsilon_t \tag{4.7}$$

The ADF will test for the lagged GP through the null hypothesis and alternative hypothesis are as follows, $H_0 : \omega = 0$ and $H_1 : \omega < 0$, based on the following equation

$$\Delta lGP_t = \omega + \psi lGP_{t-1} + \sum_{j=1}^{q} \nu_t lGP_{t-1} + \varepsilon_t \tag{4.8}$$

The augmentated Dickey-Fuller is said at best viewed as an approximation. One more criticism of the ADF test is that it cannot distinguish between unit root and near unit root process (Naik, 2013). A solution is offered by Phillips and Perron (1988), who finds a non-parametric way of adjusting the estimated variance so that the tabulated distribution is valid (Sjo, 2008). Therefore, the Phillips and Perron (1988) unit root testing is also utilised to conclude with certainty the order of integration, affirm the findings of the ADF test, thereby conclude with certainty the unit root. One needs only to estimate a first-order autoregression with a constant and possibly a, time trend and to calculate the appropriate transformed statistic (Phillips & Perron, 1988). However, it should be noted that a graphical presentation will precede the conventional unit root testing and make a visual inspection to anticipate the likely integration order.

4.5.2 Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model.

In determining the economic risk exposure in stock market returns for the oil and gas sector the GARCH model is employed to measure volatility. Volatility is a process of change in behavior, value or investment over the time and cumulative persistence of that change to the next phase (Ahmad & Ramzan, 2016). However, the GARCH model is an extension of the autoregressive conditional heteroskedasticity (ARCH) model, it is necessary to explain the ARCH as it holds conditions for the application of the GARCH model. Sariannidis, Giannaraski, Litinas & Konteos (2010) give the specifics of the ARCH model, in that, it allows the conditional variance of a time series to change over time as a function of past squared errors by imposing an autoregressive structure on conditional variance and allowing volatility shocks to persist over time. ARCH and GARCH models have become common tools for dealing with time series hetroskedastic models; these models provide a volatility measure that can be utilized in portfolio selection, risk analysis and derivative pricing (Tully & Lucey, 2007)

The ARCH model through the 'ARCH-effect' is used as the first stage of increasing volatility, thereby, measuring changes in variance and volatility. This model is applied when high impact volatility is detected and existence of heteroskedasticity in the data. Also, ARCH models study the second moment (Conditional and non-conditional) of the time series, and thus allow the variance of a series to depend on the available information set (Al-Zararee & Ananzeh, 2014). The ARCH's ability to capture the non- linearity and volatility clustering in stock return data is one of its benefits. As has already cited, it is desirable or a condition to test whether it is fitting before proceeding with the GARCH model estimation. In a linear regression model, with or without lagged-dependent variables, ordinary least square (OLS) is the appropriate procedure if the disturbances are not conditionally heteroskedastic by running or testing the Lagrange multiplier (LM), the ARCH-LM test (Engle, 1982).

Bollerslev (1986) extended the ARCH model and developed the generalized ARCH (GARCH) model. Volatility, as measured by the standard deviation or variance of returns, is often used as a crude measure of the total risk of financial assets (Brook, 2002). This simple GARCH model is advocated to be parsimonious and to generally give significant results (Al-Zararee & Ananzeh, 2014). The standard GARCH model for the purpose of this study is given by the following equation:

$$OilGas_t = \beta_0 + \sum_{i=1}^{k=1} \beta_1 OILP_t + \sum_{i=i}^{k=1} \beta_2 EXR_t + \sum_{i=1}^{k=1} \beta_3 M3_t + \sum_{i=1}^{k=1} \beta_4 GP + \varphi_1 \sqrt{h} + \varepsilon_t \qquad (4.9)$$

$$\mu_t / \Omega_{t-1} \sim N(0, h_t^2) \qquad (4.10)$$

$$h_t^2 = \beta_0 + \lambda_1 \varepsilon_{t-1}^2 + \Phi_1 h_{t-1}^2 \quad (4.11)$$

Where β_0 is the intercepts of the regression and represents the risk free rate, $\beta_1, \beta_2, \beta_3, \beta_4$ are the coefficients of the variables and ε_t is the residual errors of the regression. β_j, λ_1 and Φ_1 are coefficients to be estimated (j=0,1,2), h_t^2 is the conditional variance which is dependent on lagged values of square errors and lagged values of the conditional variance, Ω_{t-1} is the set of all information available at time $t-1$. λ_1 and Φ_1 are the ARCH and GARCH coefficient, respectively, and all other terms assumes the usual interpretations of the GARCH model. Equation (4.1) is the conditional mean return expression, while equation (4.11) gives the distribution of the error term, conditional upon available information. Equation (4.11) gives an expression for the volatility of returns. Henceforth, the third term, h_{t-1}, is the GARCH model, measuring the impact of last period's forecast variance. λ_1 and Φ_1 help in confirming the presence of ARCH and GARCH effects, as in equation (4.11).

The simple GARCH model carries with it the following benefits, thereby appealing, advocating for its use in assessing risks through measuring volatility of the variables concerned in relation to the sector returns:

- The benefit of GARCH model is that, it takes small number of terms and show better results than an ARCH higher order model (Attari &Safdah, 2013)
- This model is designed to account for a time-varying variance that usually is associated with high frequency financial and economic data (Nkoro & Uko, 2013)
- The appeal of the models is its ability to capture both volatility clustering and unconditional return distribution with heavy tails
- With a small number of terms seems to perform better than an ARCH model with many terms (Oseni & Nwosa, 2011)

Additionally, the study utilises the Root Mean Square Error (RMSE) from the mean equation of the Oil & Gas sector stock returns model forecast. This is also called the Root Mean Square Deviation (RMSD), a frequently used measure of the difference between values predicted by a model and the values actually observed from the environment that is being modelled. The RMSE equation is defined as:

$$RMSE = \sqrt{\sum_{i=1}^{n} (X_{obs,i} - X_{model,i})^2 \div n} \qquad (4.12)$$

Where, $X_{obs,i}$ is observed valued and $X_{model,i}$ is modelled values at time/place i. Other statistical indices usually used for the return of forecasting are the Mean Absolute Error (MAE) and the Mean Absolute Percentage Error (MAPE); the lower the values of the RMSE, MAE and MAPE indices, the better the forecast of model (Dritsaki, 2017).

4.5.3 Cointegration

To test for cointegration between the time series we rely on Johansen (1991) likelihood ratio tests for evaluating the number of cointegration vectors within the system of time series. In addition, if these variables are cointegrated, then we can exploit the idea that there may exist comovements in their behaviour and possibilities that they will trend together towards a long-run equilibrium state (Ghali and El-Sakka, 2004). When carrying out the maximum likelihood estimation, the Johansen cointegration uses the following equation for a long run (LR) relation:

$$LR_{trace} = -T \sum_{i=r+1}^{k} \ln(1 - \hat{\lambda}) \qquad (4.13)$$

$$LR_{\max} = -T \ln(1 - \hat{\lambda}_{r+1}) \qquad (4.14)$$

Equation (4.13) is the trace test and equation (4.14) is the maximum eigenvalue test, both represents two different forms of determining the long-run Johansen cointegration. T in both equation is the sample size and λ is the i^{th} largest recognised correlation. Trace statistics tests the null hypothesis of no cointegration $H_0 : r = 0$ against the alternative of zero cointegrating vector $H_1 : r \succ 0$, whereas the maximum Eigenvalue statistics test the null hypothesis of r cointegration vector against the $r+1$ cointegrating vector.

Henceforth, if these variables are cointegrated, the cointegration vector will reflect the magnitude of the impact of each variable on the long-term level of the stock market (Moolman & Du Toit, 2005). However, presentation of cointegration is preceded by a determination of the lag length criteria, that is, how many lags to be included in the model. The lag length selection determines which month selection would have significance on the current results (Poku, Sarkodie & Mireku, 2013).

4.5.4 Granger causality

Granger (1988) causality test is explored to observe the dynamic linkage between the dependent and independent variables. The essence of the test is to analyses a given fact that between two components which one is initiating or causing the other and which component is being affected by the other. The test is based on following two regression equations:

$$Y_t = \sum_{i=1}^{p} \delta_i X_{t-i} + \sum_{j=1}^{p} \chi_j Y_{t-j} + \varepsilon_{1t} \tag{4.15}$$

$$X_t = \sum_{i=1}^{p} \gamma_i X_{t-i} + \sum_{j=1}^{p} \phi_j Y_{t-j} + \varepsilon_{2t} \tag{4.16}$$

There are four possible direction of causality:

- Unidirectional causality, this form of causality implies that causality from X to Y is indicated when the estimated coefficient on lagged equation (4.15) are statistically different from zero as a group (i.e. $\sum \delta_i \neq 0$) and the set of estimated coefficients on the lagged Y in equation (4.16) is not statistically different from zero (i.e. $\sum \phi_j \neq 0$).
- Unidirectional causality, from Y to X is indicated when the estimated coefficient on lagged equation (4.15) are statistically different from zero as a group (i.e. $\sum \phi_j \neq 0$) and the set of estimated coefficients on the lagged Y in equation (4.15) is not statistically different from zero (i.e. $\sum \delta_i \neq 0$).
- Feedback or bi-directional causality occurs when both the X and Y set's coefficients are statistically significant in both the equation.
- Neutrality, this is when both sets of X and Y coefficients are statistically insignificant.

Sahu, et al (2014) puts it bluntly that despite the importance of conducting causality tests, the empirical inferences based on the causality test do not determine the strength of the causal relationships between the variables nor do they describe the relationship between these variables over time. For the purpose of causal strength, the impulse response function and variance decomposition are utilised, as described in detail in the subsequent section.

4.5.5 Diagnostic test

The major test, especially after employing the GARCH model, is the heteroskedasticity tests, by running the ARCH-LM test through the GARCH residual process to test whether the problem of heteroskedasticity is corrected.

4.5.6 Stability test

A second test is the inverse of roots AR characteristics of polynomial which test the Stability of the Stationary VAR system, the test will yield positive outcome when no root lies outside the unit circle, given unit circle, thus the VAR satisfies the stationarity condition.

Furthermore, for stability of the model study the cumulative sum (CUSUM) test is employed to check for steadiness of the model throughout the period. Stability of the model is observed when the cusum line move inside the two critical lines

4.5.7 Impulse response function

The next technique to be carried out is the impulse response function to trace the effect of a one-time shock function to one of the innovations on current and future values of the endogenous variables. In essence, the impulse response describes the oil and gas stock return's reaction as a function of time to the underlined economic factors at the time of the shock and subsequent points. Thereby, shows the effects of shocks on the adjustment path of the variables (Brooks, 2002). The impulse response uses the VAR system to examine how each of the variables responds to innovation the other variables, which is, mapping out a dynamic response path of variable due to one standard deviation shock on each other.

4.5.8 Variance decomposition

West and Macfarlane (2013) postulates that unlike the impulse response function, which trails the effects of shocks to one variable on the other variable in the VAR, the variance decomposition, however, separates the variation of the macroeconomic variables into the constituent shocks of the VAR. Henceforth, a measure of the contribution of each type of shock to the forecasted error variance entails running forecast error variance decomposition (Brooks, 2002). Ordering of the variables is important to differentiate the calculation of impulse responses and variance decompositions because they are almost similar.

4.6 SUMMARY

The chapter gave a detailed revelation of the data and its source, thereafter, a detailed model specification of the study was presented. Since the data had to be altered to give effect to returns, relevant variables for this purpose, that is, oil and gas share prices, brent crude oil prices, broad money supply and gold prices were converted to yield change on a month on month bases.

Thereafter, for the purpose of determining the long-run relationship in the study cointegration through the Johansen cointegration (1991) likelihood test is presented as the anticipated and appropriate test to be carried out. However, dealing with time series variable requires a prior unit root tests, and the augmented Dickey-Fuller test and the Phillips Perron tests are presented as the techniques for purpose of testing stationerity and order of integration, thereby avoiding spurious and unreliable models. Furthermore, a simple ARCH/GARCH model is presented to test how volatility in economic fundamentals affects the oil and gas sector returns. This model is said to be well suited for this purpose because of its power to deal with high level presence of heteroskedasticity, which is tested through the ARCH effect.

Granger causality is allocated for the study to espouse the direction of causality in the variables. However, because Granger causality does not reveal the type of relationship and the strength of causality additional relevant techniques are employed to overcome this shortcoming. Thereafter the impulse response function and variance decomposition are presented; the essence is to explain the oil and gas stock return's reaction through time to the underlined economic factors at the time of the shock and subsequent points.

The variance decomposition is presented to give an even more robust outcome, since reference is given to the order.

CHAPTER 5

DISCUSSION / PRESENTATION / INTERPRETATION OF FINDINGS

5.1 INTRODUCTION

This chapter is presented to give an exhibition of results of each individual technique in order of procedure as presented in chapter three. Henceforth, detailed feedback and discussion of outcome regarding all econometric techniques are narrated to report the empirical findings. E-views software is used to test all the estimations, that is, unit root tests, the GARCH model, Johansen cointegration tests, Granger causality test, impulse response function and variance decomposition, and lastly the diagnostic test and stability test.

5.2 EMPIRICAL TESTS RESULTS

This subsection is aimed at giving and reporting the findings of the econometric results in the order they appeared in chapter 3.

5.2.1 Stationarity/Unit root tests results

The analysis of unit root is preceded by a graphical presentation of the data to help anticipate the behaviour of variables through visual inspection.

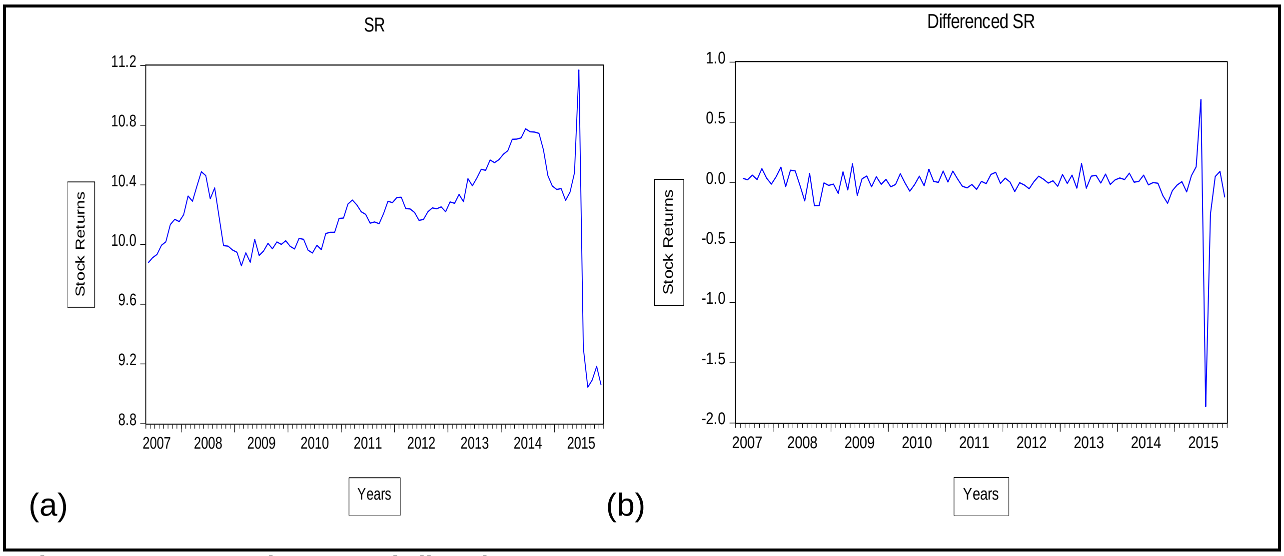

Figure 5.2.1.1: Stock returns (OilGas)

Source: Author's computation with E-Views 9.0

Figure 5.2.1.1 presents graphical representation for the oil and gas sector stock returns, from the visual inspection it is expected that the data will be stationery after differencing as the mean appears to strongly hover around a mean of zero horizontally along the X-axis at plot (b) as opposed to plot (a), which appears to have an influence of time.

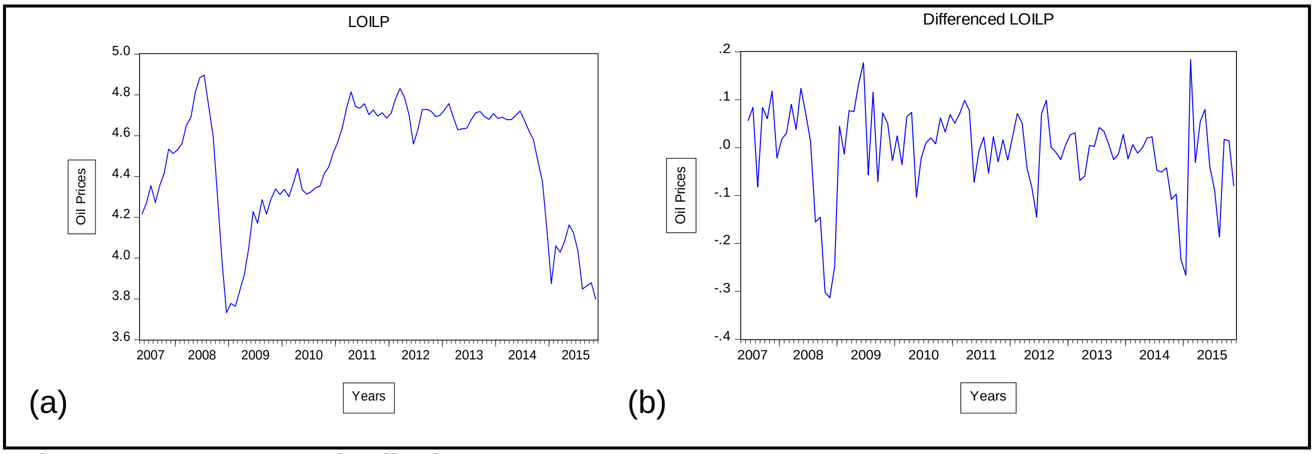

Figure 5.2.1.2: Brent crude oil price

Source: Author's computation with E-Views 9.0

In figure 5.2.1.2 plot (a) seems not to be trending, however, the inconsistency of its mean is not satisfactory for the log oil prices. However, plot (b) the differenced log of oil certifies the condition of stationery, with the mean hovering around the mean of zero horizontally along the X-axis.

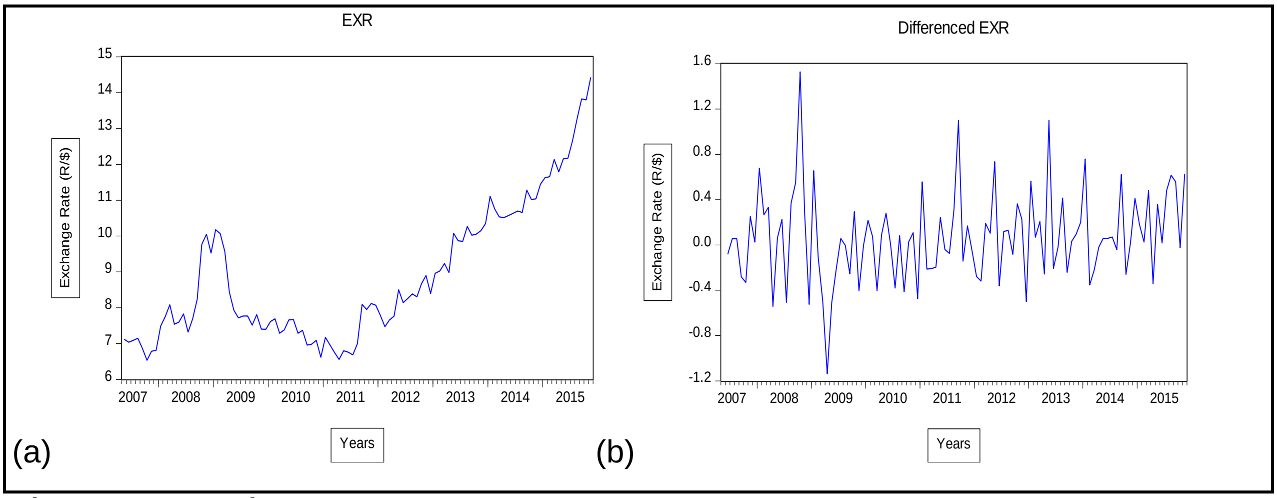

Figure 5.2.1.3: Exchange rate

Source: Author's computation with E-Views 9.0

With figure 5.2.1.3, stationarity is expected after first difference, with the mean perfectly hovering along the x-axis in plot (b) as opposed to plot (a), which appears to have an influence of time.

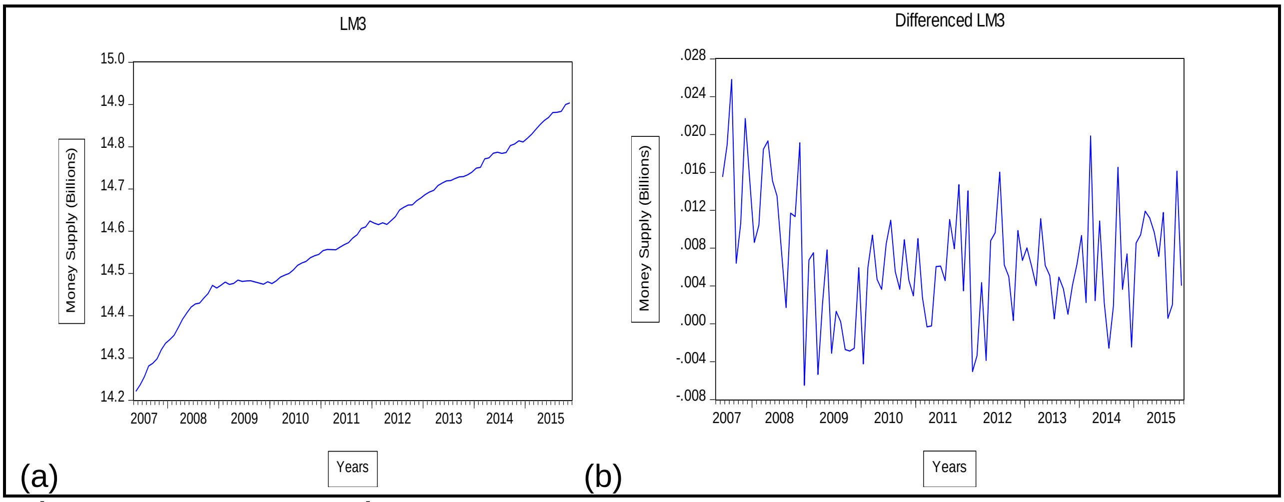

Figure 5.2.1.4: Money supply
Source: Author's computation with E-Views 9.0

From the visual inspection it is expected that the data will be stationery after differencing as the mean appears to hover around a mean of zero horizontally along the X-axis at plot (b) as opposed to plot (a) at figure 5.2.1.4 (a), the log of money supply, which is clearly trending, that is, influenced by time.

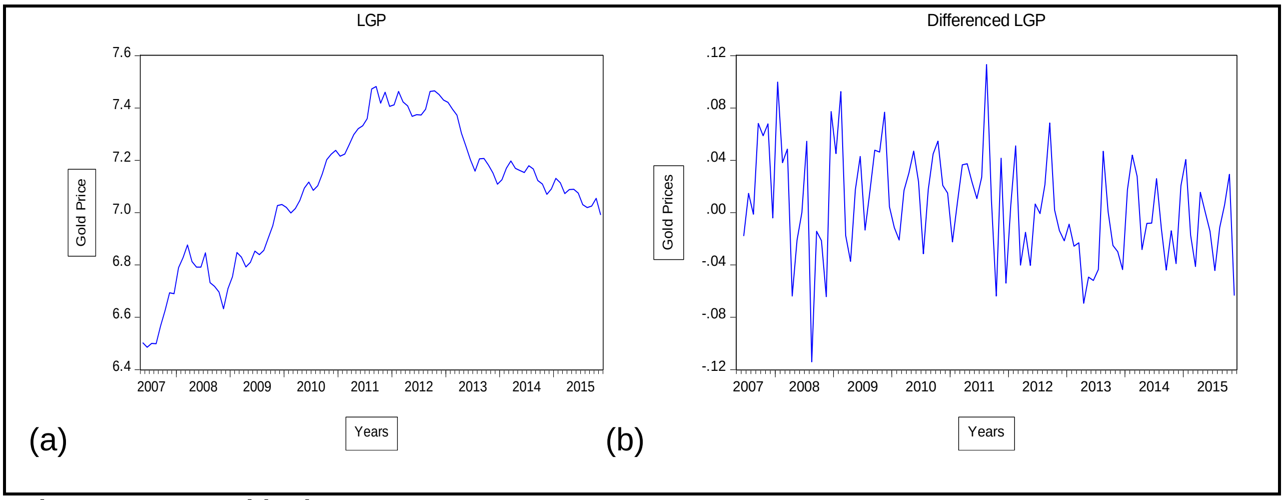

Figure 5.2.1.5: Gold price
Source: Author's computation with E-Views 9.0

Also for figure 5.2.1.5, the graphical representation log of gold price, from the visual inspection it is expected that the data will be stationery after differencing as the mean appears to hover around a mean of zero horizontally along the X-axis at plot (b) as opposed to plot (a), which appears to have an influence of time.

Table 5.2.1.1: unit root results

Variables	Model specification	ADF test	PP test	Conclusion
SR	Intercept	-2.413777	-2.377544	Non stationery
	Trend and intercept	-2.143744	-1.961114	Non stationery
	None	-0.460261	-0.507869	Non stationery
lOILP	Intercept	-1.880496	-1.733579	Non stationery
	Trend and intercept	-1.796924	-1.604833	Non stationery
	None	-0.513547	-0.430496	Non stationery
EXR	intercept	0.835466	0.865273	Non stationery
	Trend and intercept	-0.678735	-0.701016	Non stationery
	None	1.954947	1.944601	Non stationery
LM3	intercept	-2.315663	-1.657102	Non stationery
	Trend and intercept	-3.906234***	-3.622237***	Stationery
	None	10.38232	6.474112	Non stationery
LGP	intercept	-2.353641	-2.277052	Non stationary
	Trend and intercept	-0.683367	-0.739907	Non stationery
	none	1.092230	0.936583	Non stationery

Source: Author's computation with E-Views 9.0

*, ** and *** implies rejection of the null hypothesis at 1%, 5% and 10% respectively

After running the ADF and the PP tests for unit root testing table 5.2.1.1 presents the results by testing the null hypothesis that Share Returns, Log of oil prices, USD/ZAR exchange rate, log money supply and the log of gold prices are non-stationery. The unit root testing was tested for all equations at intercept, trend and intercept, and at none, incorporating all regression forms to conclude without doubt the level of stationarity for all variables. The tests were carried out at all regression forms based on the automated

SIC lag length for ADF and PP automated at Newey-West using Bartlett Kenel. The variables are showing signs of trending and the data is influenced by time at all specifications, hence, the variables are non-stationery at level, that is, the null hypothesis is maintained and thus holds at level.

Table 5.2.1.2: Unit root results of variables at first difference

Variables	Model specification	ADF test	PP test	Conclusion
D(SR)	Intercept	-11.70461	-11.72363	Stationery
	Trend and intercept	-11.83941	-12.27345	Stationery
	None	-11.74241	-11.76109	Stationery
D(lOILP)	Intercept	-6.357426	-6.389188	Stationery
	Trend and intercept	-6.448033	-6.489631	Stationery
	None	-6.374281	-6.406344	Stationery
D(EXR)	intercept	-9.835317	-9.840535	Stationery
	Trend and intercept	-10.04903	-10.04905	Stationery
	None	-9.563426	-9.624374	Stationery
D(LM3)	intercept	-7.653431	-8.025927	Stationery
	None	-3.102292	-5.022264	Stationery
D(LGP)	intercept	-8.022509	-8.022509	
	Trend and intercept	-8.657160	-8.597968	Stationery
	none	-7.968137	-7.966167	Stationery

Source: Author's computation with E-Views 9.0

*, ** and *** denotes rejection of the null hypothesis at 1%, 5% and 10% respectively.

Table 5.2.1.2 follows the same procedure as in table 1, however, all the variables are tested for unit root at first difference to test the null hypothesis. Both the ADF and PP conclude beyond doubt, that the variables are stationery at first level. Therefore, the variables are integrated at an order of I(1)

Table 5.2.1.2 presents the differentiated form of all variables concerned interpreted at all specifications, intercept, trend and intercepts and none. The null hypothesis, that is, non-stationarity is rejected.

5.2.2 Generalised autoregressive conditional heteroskedasticity (GARCH) model

Table 5.2.2.1 reveal the findings of the ARCH-LM test, as mentioned that it is desirable or a condition to test whether it is fitting before proceeding with the GARCH model estimation. The table reports a p-value of 0.0362 for the F-statistic in relation to the ARCH-LM test. This demonstrates the presents of ARCH effects, thus proving the appropriateness of the GARCH model in the context of this study.

Table 5.2.2.1: ARCH-LM, Heteroskedasticity test

F-statistic	4.511745	Prob. F(1,99)	0.0362
Obs*R-squared	4.402266	Prob. Chi-Square(1)	0.0359

Source: Author's computation with E-Views 9.0

The next step is to determine the GARCH estimates to reveal whether changes in macroeconomic factors, and Brent Crude prices in particular, have an effect on the Oil & Gas stock returns. For this purpose, the study proposes a simple linear regression model to capture the conditional mean of a return process. Alexander (2001) puts it that in a factor model regression the expected value of a stock return will change over time, as specified by its relationship with the market return and any other explanatory variable.

The study uses the commonly used GARCH (1, 1) model estimating using Generalised Error Distribution (GED). This estimation formation is favoured because of Kosapattaarapim (2013) who postulated that the best fitting model is GARCH (1, 1) with GED. This application is more efficient and flexible not only because it can accommodate both normality and non-normality within one model but also because it is as easy to use as the variance-covariance method (Changchien & Lin, 2011). E-Views automated the model distribution to Z-Statistics.

Table 5.2.2.2: GARCH Model Estimates of the ML ARCH - GED

Panel A: Mean Equation

Variables	**coefficients**	**Std. Error**	**z-Statistic**	**Prob**
@SQRT(GARCH)	-0.908489	0.420565	-2.160165	0.0308
OILP	0.534053	0.034620	15.42601	0.0000
EXR	-0.172949	0.051190	-3.378571	0.0007

M3	0.579212	0.326326	1.774951	0.0759
GP	-0.381880	0.053656	-7.117130	0.0000
C	0.202768	0.131425	1.542836	0.1229

Panel B: Variance Equation

Variables	**coefficients**	**Std. Error**	**z-Statistic**	**Prob**
C	0.028513	0.023070	1.235969	0.2165
ARCH:RESID(-1)^2	0.052018	0.014470	3.594826	0.0003
GARCH(-1)	0.478996	0.204113	2.346723	0.0189
		0.531		

Source: Author's computation with E-Views 9.0

Table 5.2.2.2 discloses the results of the GED estimates, where Panel A presents the mean equation of the model and Panel B presents the variance equation of the model. With regard to the relationship between the Oil and Gas sector returns and the change in macroeconomic variables espoused as the economic risk factors the mean equation reveals the following results.

It is revealed that change in Brent crude oil prices has a positive or increasing-mean effect in the Oil & Gas sector stock returns, which is statistically significant at 1% level. These findings are in line and supplement recent findings by Szczygielski & Chipeta (2015). Therefore, this means as brent crude oil prices increase so does the Oil & Gas sector stocks realise increasing returns. As such, the null hypothesis is rejected and the alternative holds. Therefore, changes in oil prices have an effect on return of Oil & Gas stock returns.

On the other macroeconomic variables, change in exchange rate has a negative or diminishing-mean effect on the sector's stock returns, which is statistically significant at 1% level. Hsing (2014) tested and found similar results with effective nominal exchange rates. Consequently, a depreciation of the Rand/Dollar exchange rate has a dampening effect on the Oil & Gas sector stock returns. This holds because as the rand value declines, it means the cost of purchasing a unit barrel increases, therefore, impacting on the profit margins, *ceteris paribus*.

Change in broad Money supply has a positive or increasing-mean effect on the sector stock returns, but only statistically significant at 10% level. These findings are in line with Szczygielski & Chipeta (2015) and Hsing (2014) who also found a positive relation. Henceforth, an injection or increase in money supply has an added benefit in the said sector stock returns.

Change in gold prices have a negative or diminishing-mean effect on the Oil & Gas sector returns, which is also significant at 1%. According to the author relevant studies are lacking in the South African context; foreign studies do advocate a possibility of these findings. Moore (1990) found that gold prices and the stock markets had a negative correlation, that is, when gold prices were rising, the stock markets were declining in the New York Stock Market**.** Perhaps, the notion that gold plays a vital role as a safe haven is affirmed. As gold prices rise, investors view gold as an alternative instead of other markets like the Oil & Gas sector, affecting the sector undesirably.

The variance equation in panel B illustrates that, the ARCH and GARCH coefficients are found to be significant, with both estimates appearing as positive. This offers evidence of ARCH and GARCH effect on volatility of stock returns. Henceforth, this displays that there is volatility clustering in the Oil and Gas market. With low values it is can concluded that the volatilities associated with each of the significant variables do not last for long before it fades away. The positive sign of the ARCH observed is in line with Engle (1982) and Bollerslev’s (1986), whose emphases are on a non-negative estimate of the ARCH.

The next step is to determine how accurate the model is, though one may say this undertaking should be in the diagnostic section of the paper. This ensures a consistent flow of GARCH model results dissemination. This is done by forecasting the model, however, with the sole main aim of revealing certain indicators for purpose of model accuracy. Figure 5.2.2.1 shows the forecast of the volatility of the Oil and Gas sector returns based on the mean equation. This forecast the future values on rate of return and volatility on the Oil and Gas sector returns.

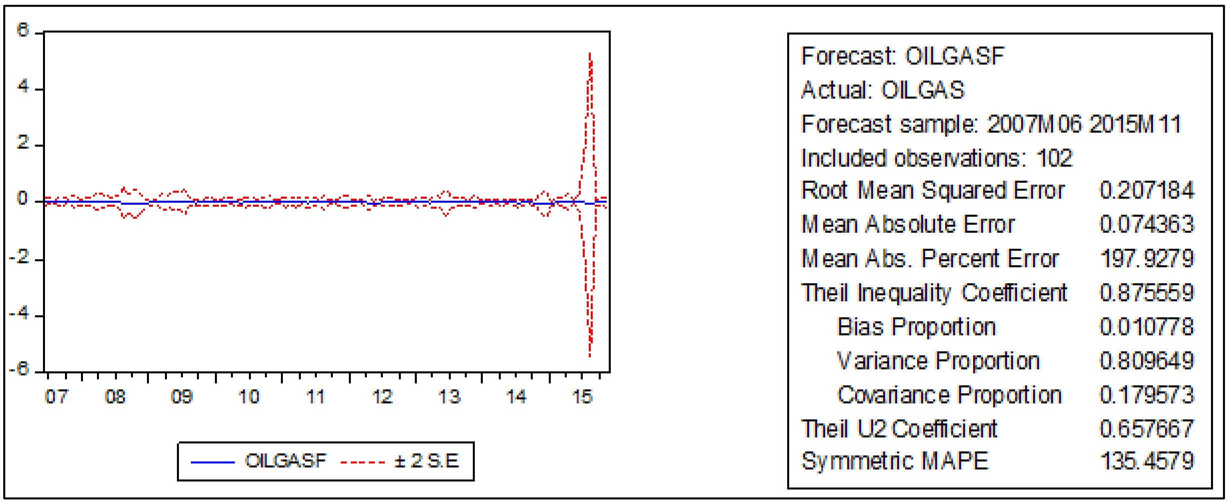

Figure 5.2.2.1: OilGas forecast based on the mean equation
Source: Author's computation with E-Views 9.0

Statistical indices usually used for the return of forecasting are the Mean Absolute Error (MAE), the Root Mean Square Error (RMSE), and the Mean Absolute Percentage Error (MAPE) (Dritsaki, 2017). Henceforth, the better the forecast model then the mean equation results as per the model may be concluded to be accurate. As reflected on figure 5.2.1, the RMSE, MAE and MAPE are 0.207184 and 0.0744369 and 197.93 respectively. The Root Mean Square error is the most powerful criterion for the evaluation of the model (Patton, 2006).

5.2.3 Cointegration test results

Table 5.2.3.1 presents the lag length criteria and the lag order selection criteria as stated by FPE, SC and HQ reveals a lag order of one, while AIC determines a lag order of two and LR has a lag order of six. Henceforth, the chosen lagging is one, since most criteria advocate for it.

Table 5.2.3.1: Lag length criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-14.71935	NA	1.04e-06	0.415144	0.549559	0.469458
1	626.3302	1201.124	2.43e-12*	-12.55432	-11.74783*	-12.22844*
2	651.3366	44.22190	2.44e-12	-12.55446*	-11.07590	-11.95701
3	664.7390	22.29019	3.15e-12	-12.31029	-10.15966	-11.44128
4	681.3935	25.94602	3.83e-12	-12.13460	-9.311894	-10.99402
5	702.4558	30.59568	4.31e-12	-12.05170	-8.556921	-10.63955
6	746.2343	58.98582*	3.06e-12	-12.44704	-8.280186	-10.76332
7	765.3885	23.79150	3.73e-12	-12.32397	-7.485043	-10.36868
8	786.6602	24.18256	4.48e-12	-12.24548	-6.734480	-10.01862

Source: Author's computation with E-Views 9.0
* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 5.2.3.2 discloses the cointegrating integration results, the trace statistics is greater than the critical value at none hypothesis, therefore the trace test has a one cointegrating equation, so there exists a long-run relationship between stock returns and the economic factors.

Table 5.2.3.2: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.358495	90.29206	69.81889	0.0005
At most 1	0.179214	47.23003	47.85613	0.0572
At most 2	0.133373	28.07323	29.79707	0.0780
At most 3	0.117345	14.18801	15.49471	0.0779
At most 4	0.021218	2.080337	3.841466	0.1492

Source: Author's computation with E-Views 9.0
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Similarly, the Maximum Eigenvalue has one cointegration equation as revealed by table 5.2.3.3 at 5% level of significance.

Table 5.2.3.3: Unrestricted Cointegration Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.358495	43.06203	33.87687	0.0031
At most 1	0.179214	19.15680	27.58434	0.4025
At most 2	0.133373	13.88522	21.13162	0.3745
At most 3	0.117345	12.10768	14.26460	0.1067
At most 4	0.021218	2.080337	3.841466	0.1492

Source: Author's computation with E-Views 9.0
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 5.2.3.4: Long-run conintegrating equation

SR	OILP	EXR	M3	GP
1.000000	-6.403250	94.15255	-253.9162	47.75616
	(7.01953)	(20.6545)	(81.6696)	(14.8799)

Source: Author's computation with E-Views 9.0

Table 5.2.3.4 reveals the long-run relationship between the oil and gas share returns and the economic factors in the model as per the cointegration results. Values in bracket represent t-statistics.

The coefficients are a measure of elasticity, that is, how much does a percentage change in one economic indicator affect the share returns in the sector understudy. The estimated co-integrating coefficients for the Oil & Gas sector returns based on the first normalized equation are as follows.

$$OilGas_t = \beta_0 + 6.4032OILP_t - 94.1526EXR_t + 253.9162M3_t - 47.7561GP_t + \varepsilon_t \qquad (5.1)$$

(7.01953) 20.6545) (81.6696) (14.8799)

These results are in opposition of the findings of Ajayi & Olaniyan (2016), at least for the oil and gas sector, there exists long-run relationship. All macroeconomic variables are statistically significant. Brent crude oil price and broad money supply have a positive long-run relationship with the sector share returns. These findings suggest the same relationship as per the GARCH model giving further evidence that oil prices and money supply have a beneficial relation as these economic factors trend upwards. A one percentage change in broad money supply will yield a positive feed on share returns. West & Macfarlane (2013) also espoused a positive relationship in money supply-stock return nexus.

On the other hand, exchange rate and gold prices have a negative impact on the sector in the long-run. West & Macfarlane (2013) also found a negative relation in the long-run between exchange rate and stock returns. Ntshangase, et al (2014) and Tripathi & Kumar (2015) also found a negative relation. Considering that South Africa imports all of its crude requirements, energy companies which use crude oil as feedstock will face a higher Rand price of crude oil, hence the negative relationship as costs of purchases increase. If exchange rate of home currency with respect to dollar increases it will affect the cash flows in a negative manner and reduce the return (Saeed, 2012). The gold prices-stock market nexus is further given impetus as the negative relationship is also found by the long-run relationship.

5.2.4 Granger causality tests results

To measure the causality relation among variables, the Granger causality test is utilised for this purpose. Table 5.2.4.1 shows the causality findings, and results are as follows:

Table 5.2.4.1: Granger Causality Tests

Null Hypothesis	Obs	F-Statistics	Prob
OILP does not Granger Cause OILGAS OILGAS does not Granger Cause OILP	100	2.50099 3.52685	0.0874*** 0.0333**
EXR does not Granger Cause OILGAS OILGAS does not Granger Cause EXR	100	0.34016 0.86485	0.7125 0.4244
M3 does not Granger Cause OILGAS OILGAS does not Granger Cause M3	100	0.08293 0.94608	0.9205 0.3919
GP does not Granger Cause OILGAS OILGAS does not Granger Cause GP	100	0.79770 0.19299	0.4534 0.8248

Source: Author's computation with E-Views 9.0

*, ** and *** represents significance at 1%, 5% and 10% levels.

The Oil & Gas sector stock returns and oil prices are seen to have a bi-directional causal relationship, however, significant at varying levels. Oil prices have a causal effect on Oil & Gas stock returns at 10% level of significance, while Oil & Gas stock returns causal effect on oil prices is at 5%. This means during the period 2007 to 2015 movements in one indicator would alter change the other as per the relationship. A more relevant analysis is that by monitoring oil prices movements market players are able to extrapolate the sector stock returns. However, stock returns and exchange rates, stock returns and money supply, share returns and gold price have no direct causality at all relevant levels. The neutrality hypothesis in exchange rate and share returns is consistent with Ocran (2010).

5.2.5 Diagnostic tests results

After it was fitting to run the GARCH estimation as revealed by the presence of heteroskedasticity by testing the ARCH-LM test through the OLS procedure, post estimation a diagnostic test is required to assess whether this problem is corrected. Table

5.2.5.1 shows the ARCH-LM test after the heteroskedasticity was run through the GARCH residual process.

Table 5.2.5.1: Heteroskedasticity Test: ARCH

F-statistic	0.198968	Prob. F(1,100)	0.6565
Obs*R-squared	0.202544	Prob. Chi-Square(1)	0.6527

Source: Author's computation with E-Views 9.0

The diagnostic test measuring the presence of heteroskedasticity is rejected through the ARCH test as revealed in table 5.2.5.1. The probability of the 0.6565 greater 0.5 rejects the null hypothesis of heteroskedasticity. This test further justifies the reliability of the GARCH model, which then gives impetus to the results as significant and reliable. This test is also formulated on the same principle and similar formulas as the white test and the bruesch Pagan test.

5.2.6 Stability tests results

Stability are a necessary and helpful tests used to assess whether the model specified is stable enough to can be trusted to yield reliable results. In essence the idea is to avoid explosive model specifications or equations.

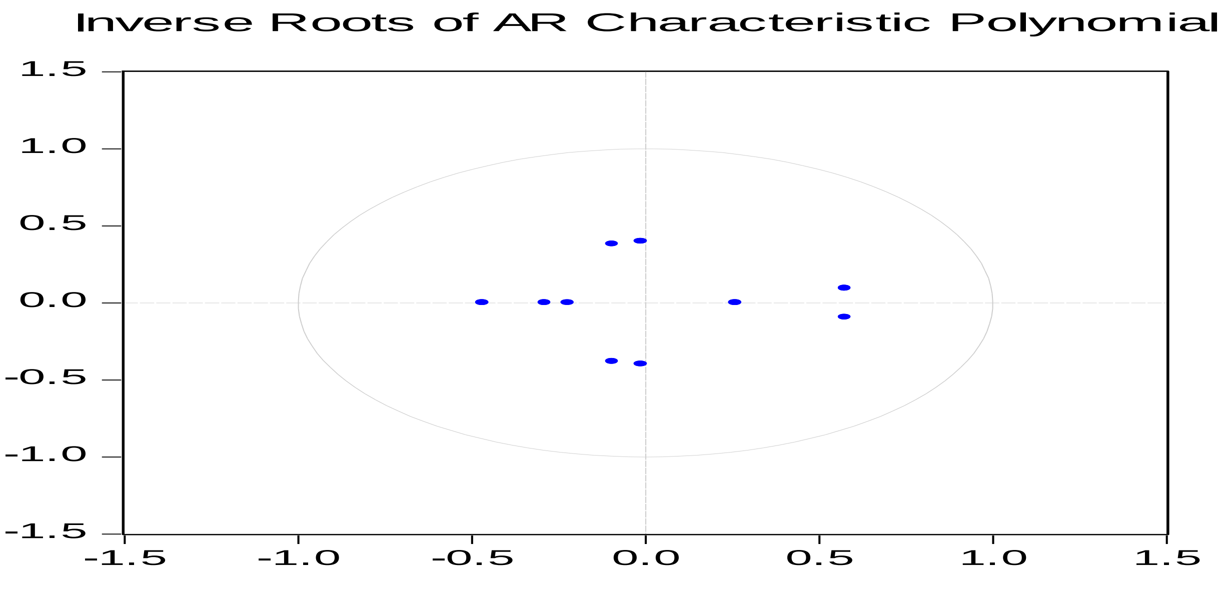

Figure 5.2.6.1: Stationarity reliability test

Source: Author's computation with E-Views 9.0

Figure 5.2.6.1 depicts the inverse roots of AR characteristics polynomial graph, which confirms that stationarity is correct as all the dots are situated inside the unit circle. Therefore, the model has no unit root.

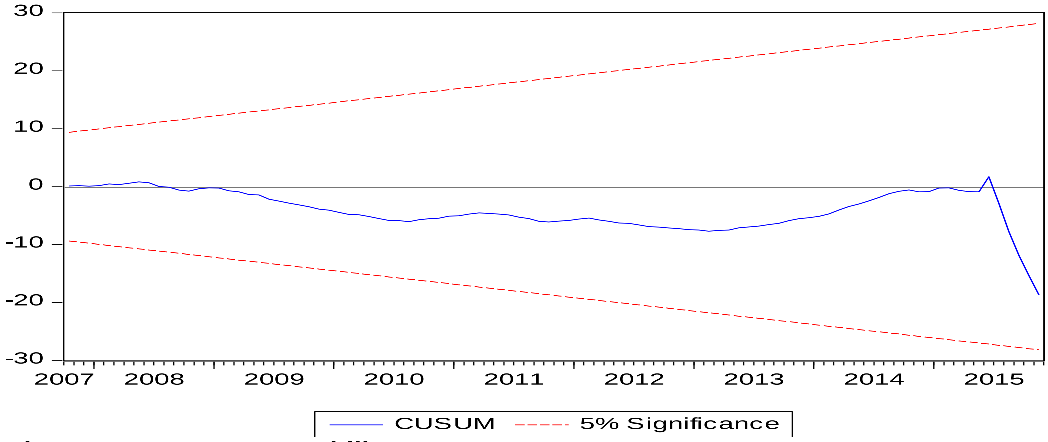

Figure 5.2.6.2: Cusum stability test

Source: Author's computation with E-Views 9.0

From figure 5.2.6.2 the cusum square reports satisfying results, in that, the blue cusum line moves inside the two red critical lines which is a condition for stability. Henceforth, the Oil & Gas stock returns model is stable and reliable.

5.2.7 Generalised Impulse Response Function results

The results of the impulse response functions are illustrated in various combined graphs, figure 5.2.7.1 reflect the dynamic response of the oil and gas share returns to shocks in the variables of the VAR system. However, a more detailed analysis is given to the response of stock returns due to shocks on the independent economic factors, while other shocks among themselves are related were significance is relevant to the sector share returns.

A shock on brent crude oil prices has a positive nock on effect on the sector stock returns responsiveness, and this is an immediate positive response from month one all the way to the tenth month. These are relevant and expected outcome as Wakeford (2006) asserts that the most immediate, direct effect of an oil shock is a rise in the price levels of liquid fuels for transport and other uses, and in the costs of oil-based petrochemicals. Because oil and gas sector is acknowledged for its efficiency these price increase signal positive returns. Similarly, a shock on the USD/ZAR exchange rate has a positive nock on effect in the Oil and Gas sector share returns from month one to the tenth month.

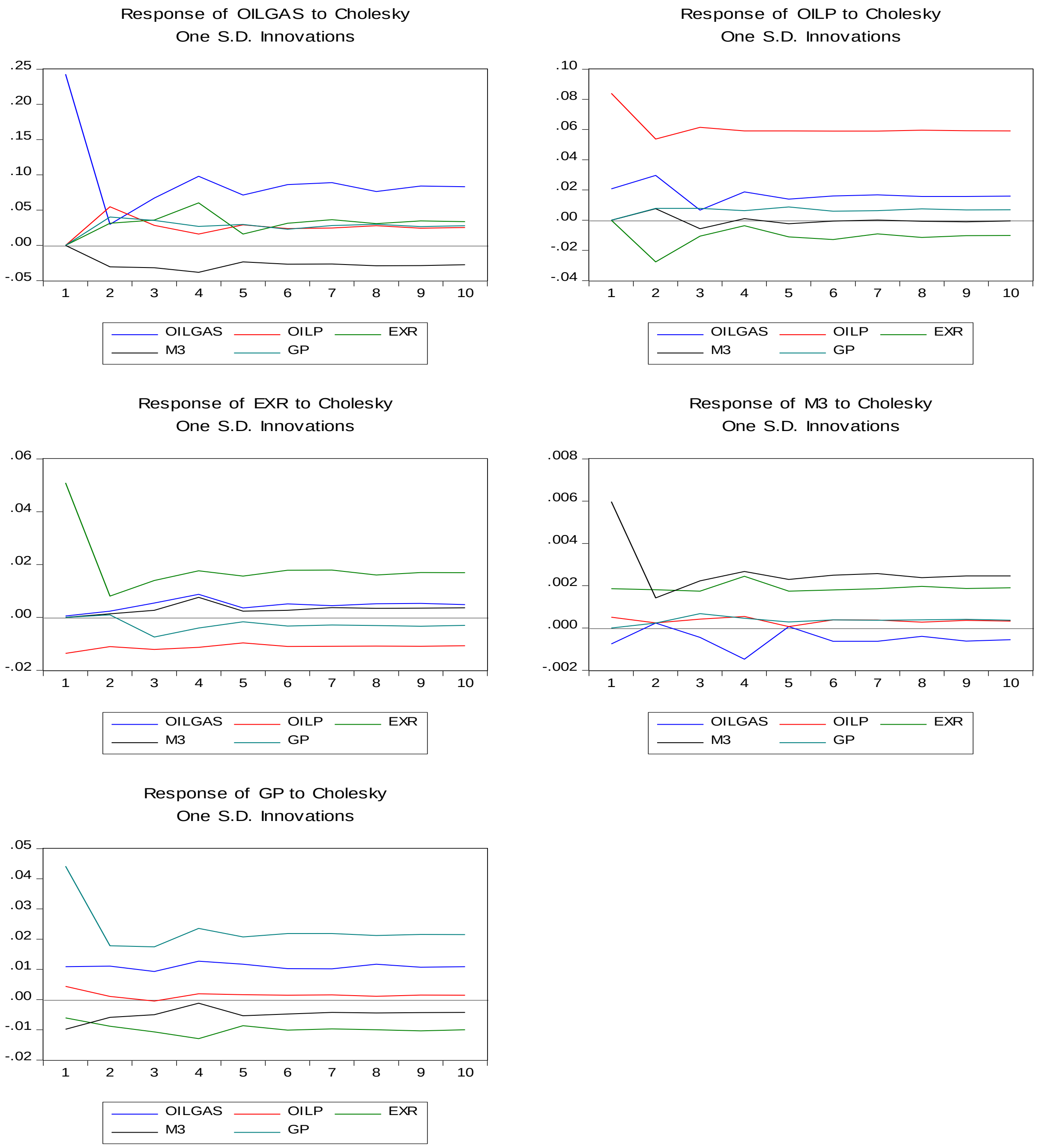

Figure 5.2.7.1: Response of Cholesky one S.D innovation

Source: Author's computation with E-Views 9.0

On the other hand, a shock to the broad money supply has a negative responsive effect in the sector. In the long run increase in money supply leads to increase the inflation which affects the return in a negative manner (Saeed, 2012). While a gold price shock causes the sector stock returns to respond positively from month one to the tenth month.

5.2.8 Variance Decomposition results

Table 5.2.8.1 presents the variance decomposition results; this technique decides how much of the forecast error variance for any variable is explained by shocks to each descriptive variables. The objective is to observe the effects of shocks to the regressed variable in the short and long-run. Short-run indicator is represented by the third period, while the long-run indicator in represented by the tenth period.

The results reflect a positive shock on Oil & Gas returns, OILP, EXR, M3 and GP. The shock in Oil & Gas returns causes 85.55% of the fluctuations in the sector returns, that is, Oil & Gas's own shock. Furthermore, the shocks in OILP causes about 5.04% of the fluctuation in the sector returns; shocks in EXR causes about 3.02% fluctuations in the sector returns, and shocks in M3 and GP causes about 2.58% and 3.81% fluctuations in the sector returns in the short-run (third month) respectively. In the long-run (tenth month) the shocks are still minimal, however, with EXR showing some improved shock effect. Oil & Gas shock and effect on itself causes a 76.16% fluctuations, while EXR causes a 7.83% fluctuations in the sector returns. OilP, M3 and GP shock effect trends is similar, hovering around the mean of 5% at 5.38%, 5.28% and 5.43% fluctuations respectively in the long-run.

The shocks in Oil & Gas cause about a 8.38% in fluctuations in OILP, and OILP causes a shock and effect fluctuations on itself of 88.88%, the shock on EXR causes about 5.40% fluctuations in OILP, shocks in M3 causes about 0.56% fluctuations in OILP, and a shock on GP causes a 0.77% fluctuations in OILP in the short-run. In the long-run the shock impact from Oil & Gas causes about 7.30% in fluctuations in OILP, while a shock and effect on itself causes a 87.75% fluctuation on OILP, a shock on EXR causes 3.66% fluctuation in OILP, a shock on M3 causes about 0.23% fluctuation in OILP, and a shock on GP causes a 1.06% fluctuation in OILP.

Table 5.2.8.1: Variance decomposition

Variance decomposition of	Period	S.E	OilGas	OilP	EXR	M3	GP
OilGas	1	0.242868	100.0000	0.000000	0.000000	0.000000	0.000000
	3	0.274280	85.55268	5.036931	3.019027	2.581164	3.810202
	10	0.387244	76.15645	5.376925	7.825196	5.207713	5.433720
OILP	1	0.086551	5.744603	94.25540	0.000000	0.000000	0.000000
	3	0.127129	8.384627	84.88318	5.404657	0.560339	0.767197
	10	0.208703	7.301846	87.74641	3.659785	0.228893	1.063069
EXR	1	0.052688	0.010811	6.655243	93.33395	0.000000	0.000000
	3	0.058362	1.046506	13.32899	83.70539	0.272888	1.646225
	10	0.081548	3.747947	19.04302	73.36901	1.981718	1.858306
M3	1	0.006327	1.430865	0.655640	8.643817	89.26968	0.000000
	3	0.007370	1.516766	0.909012	17.96570	78.65887	0.949655
	10	0.011396	3.583068	1.075813	28.08131	66.07538	1.184431
GP	1	0.047159	5.341184	0.852441	1.643659	4.353437	87.80928
	3	0.057514	9.904404	0.612561	6.908344	4.716981	77.85771
	10	i0.091614	14.33708	0.434660	11.60915	3.369431	70.24969

Source: Author's computation with E-Views 9.0

A shock on Oil and Gas sector returns causes about 1.05% fluctuation in EXR, a shock on OILP causes about 13.33% fluctuation EXR, a shock and effects on itself causes 87.70% fluctuation in EXR, a shock on M3 causes a 0.27% fluctuation in EXR, lastly a shock on GP causes a 1.65% fluctuations in EXR in the short-run. In the long-run a shock on Oil & Gas sector returns causes about 3.74% fluctuation in EXR, while a shock on OILP causes about 19.04% fluctuations in EXR. A shock and effect on itself causes 73.37% fluctuation on EXR, while a shock on M3 causes about 1.98% fluctuations in EXR. And lastly, a shock on GP causes about a 1.86% in EXR.

In the short and long-run a shock on Oil & Gas sector returns causes a lacklustre impact, about 1.52.% and 3.58% fluctuations in M3 respectively, similarly, a shock on GP has a minimal impact on M3 with 0.95% and 1.18% in respective runs. Similarly, a shock on OILP causes about 0.91% fluctuation the short-run, and a 1.07% in the long-run on M3, while a shock on EXR causes about 17.96% fluctuations in the short-run and 28.08%

fluctuations on M3 in the long-run. Lastly, a shock and effect on itself causes 78.66% and 66075% fluctuations in M3 in the short and long-run respectively.

A shock on Oil & Gas sector returns causes about 9.90% and 14.34% fluctuations in the short and long-run on GP respectively. While shock on OilP has a 0.61% and 0.43% fluctuations on GP respectively. On the other hand, a shock on EXR causes about a 6.91% fluctuation in GP in the short-run and 11.61% fluctuations in the long-run. While shocks on M3 causes about 4.71% and 3.37% fluctuations in the short and long-run respectively on GP. Lastly, shocks and effect causes fluctuations on itself by 77.86% and 70.25 in the short and long-run respectively.

5.3 SUMMARY

The study is initiated for the purpose of investigating which macroeconomic variable may espouse as risk exposure for the oil and gas market stock returns, in addition, to investigate long-run cointegration and causality. And in carrying out this task we tap feather to understand this sector relation to the broader economy. As with any time series econometric modelling, stationarity was carried out to determine the order of integration. All the variables in the study were integrated at first difference, that is, I(1). In answering the stated questions in line with the study objective results were as follows.

The GARCH (1, 1) model estimation was used for the purpose of estimating the impact of economic factor volatility on the Oil & Gas sector stock returns adopting the Generalised Error Distribution (GED). Oil prices and broad money supply had a positive relation with the sector stock returns significant at 1% and 10% respectively. While exchange rates and gold prices had a negative relationship significant at 1%. The ARCH and GARCH effect did reveal that there was volatility clustering in the sector stock returns. In investigating long-run cointegration, there was evidence of such, with oil prices and broad money supply having a positive relationship, while exchange rates and gold prices had a negative relationship in the long-run. All independent variables were seen to be significant.With respect to Granger causality only the sector stock returns and oil prices had a causal effect, with a bi-directional causality at 5% and 10% respectively.

To further advance the study, the Johansen cointegration estimate was used for the determination of whether long-run relationship was relevant. The four economic factors and sector share returns were verified to have a long-run relationship. In the long-run oil prices still have a positive relationship with share returns, which goes beyond doubt that brent crude oil as feedstock to the sector plays a vital role through its pricing. As opposed to volatility of exchange rate which had a positive relation to sector share returns, in the long-run exchange rate had a negative relationship with sector share returns. Therefore, in this instance a depreciation of the Rand against the US dollar will prove to be of detriment to the sector, reducing returns in the oil and gas sector. Monetary policy plays a vital role in its determination of money growth in the economy, in that broad money supply has a positive relation to sector share returns in the long-run. And gold price like its volatility impact has a negative relationship in the long-run.

Because of the nature of data, heteroscedasticity was highly present. However, GARCH residual process corrected the problem as reflected by the ARCH-LM test. The cusum test was utilised for purposes of testing for stability of the model, and the model was proven to be stable and reliable. While the forecast mean equation was utilised to determine how accurate the model was. With the Root Mean Square Error advocated as the most powerful criterion of measure, it was seen that the model was accurate and reliable.

CHAPTER 6

SUMMARY, RECOMMENDATIONS, CONCLUSION

6.1 INTRODUCTION

In proceeding with the charge at hand the study employed a quantitative research methodology in attaining the set aim and objectives. The four macroeconomic factors are Brent crude oil prices, the US/ZAR exchange rate, broad money supply and gold prices to see if they pose as risk exposure for the sector stock returns. This chapter is arranged to present the study summation and interpretation, give recommendations, contribution to study and limitations of the study.

6.2 SUMMARY AND INTERPRETATION OF FINDINGS

The dollar denominated oil prices play a significant role in the oil and gas sector as seen by the positive long run relationship; volatility of oil prices also impact change in sector returns positively. Therefore, sudden or persistent increases in oil price will benefits the Oil & Gas sector returns, yielding higher returns.

A tug of pricing wars by producers of brent crude oil commodity is sure to affect South Africa as a heavy importer of crude oil, henceforth demand and supply dynamics should be monitored to offset the impact of fluctuations in oil prices. For instance, OPEC member countries collaborate to push prices high by reducing production, or reduce prices through market flooding to squeeze out marginal producers. As such, oil prices have the power to cause an effect in sector stock returns. Therefore, investors should be in the look-out for Brent crude oil price fall as this will yield a fall in stock returns, hence acting as economic risk exposure for the Oil & Gas sector stock returns.

On the other hand the USD/ZAR exchange rate has an adverse impact on stock returns. Investors should therefore keep a depreciation of the Rand on hindsight as it exposes the Oil & Gas sector to diminishing stock returns. Therefore, the depreciation of the Rand act as economic risk exposure for the sector in the long-run.

Broad money supply has a positive relation with the sector returns in the long-run and even when adjusting for volatility through the GARCH. This confirm and affirm the strong form of market efficiency hypothesis. This means that the Oil & Gas sector stock returns improvements could be partly due to the central bank's monetized growth strategy through relevant policy set up, which causes money supply growth.

The gold price was seen to cause a diminishing returns in the Oil & Gas sector, either in the long-run or adjusting for volatility. This means that an improved gold index discourages industry player like portfolio and asset managers away from the Oil & Gas sector to commodities like gold. This feather promotes the notion that gold as a commodity is a safe haven asset. Henceforth, gold price increases act as economic risk exposure for the Oil & Gas stock returns. Additionally, a weaker Rand adds to the attractiveness of the gold commodity as it becomes cheaper for international investors.

6.3 CONCLUSIONS

Brent crude oil prices carry much relevance for the Oil & Gas sector stock returns because oil is the primary element of the sector. Therefore, it is highly recommended that relevant measures are put in place to offset the country's vulnerability or exposure to market manipulation by producers to safe guard the Oil & Gas sector stock returns in the interest of investors and industry players in the financial sector. This is advocated for because of the positive relationship, hence, a sudden decrease in oil prices diminishes the sector returns. And also, the bi-directional causality between the two variables.

The lack of direct causality and also a negative relationship between exchange rate and stock returns means government may use exchange rate as a policy tool to attract international investors without directly altering the oil & gas sector. This recommendation is also advocated because of the negative relationship, mitigating policies should be advocated to offset the impact of a depreciating currency on the sector returns in the long-run

Measuring for volatility and long-run relationship of Broad money supply and the sector stock returns, it is evident that the results affirm the popular believe that the country has a renowned financial sector. As continued money growth proved to add to the Johannesburg stock market through oil & gas sector returns. It is thus recommended that the relevant authorities, the South African reserve bank, maintain its objective, which is financial stability. The reserve bank should further preserve its effective regulatory infrastructure including the laws, regulations, standards and practices that constitute a robust financial regulatory environment.

Gold prices increases poses as a risk exposure in that capital or funds may be shifted away from oil & gas stocks as gold is proven to be a safe haven asset. And depreciation of the Rand adds extent to the gravity to entice international investors to prefer gold commodity as opposed to the oil & gas stocks. Risk, portfolio managers and interest players should keenly monitor gold prices to negate any losses due to gold positive performance.

6.4 CONTRIBUTIONS OF THE STUDY

The study has added to literature in respect of the much neglected sector specific studies as opposed to the much exhausted all share index macro-variables study. For instance, studies which deem oil prices not to have significance in stock returns based on all share index was proven otherwise when sector is explored. This study gives feather credence to extent this type of examination to other JSE sectors or industries.

6.5 LIMITATIONS OF THE STUDY

This study only covers a nine year period of the Johannesburg Stock Exchange sector share market due to restrictions of some variables span limitations and only four macro-fundamentals were covered. There is a host of other macroeconomic variables that may be investigated and to be analysed with huge time span to understand the nature of relationship among volatility and/or long-run relationship of macroeconomic fundamentals with stock returns of different JSE sectors.

This study has undertaken varying statistical techniques to analyse the data, especially when applying the GARCH model, however the GARCH standard deviation equation was not reported due to small time span. Many other techniques are still available to asses' risk factor of economic fundamentals which may still be utilised in the future. For instance, the IGARCH and the EGARCH models may also be explored in future studies.

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APPENDICES

APPENDIX A: DATA PRESENTATION

Date	sector Share index	Oil prices	Exchange rates	Money supply	Gold price
31-May-07	19489.54	67.69	7.1212	1499900	667.44
30-Jun-07	20167.35	71.57	7.0379	1523351	655.6
31-Jul-07	20622.25	77.85	7.0931	1552402	665.28
31-Aug-07	21911.14	71.71	7.1475	1593000	664.5
30-Sep-07	22441.86	77.97	6.8658	1603241	711.42
31-Oct-07	25171.28	82.83	6.5344	1620388	754.54
30-Nov-07	26081.84	93.19	6.7853	1655918	807.51
31-Dec-07	25701.99	91.19	6.8116	1681099	804.26
31-Jan-08	26915.07	92.78	7.4885	1695625	888.69
29-Feb-08	30516.38	95.66	7.7538	1713397	923.27
31-Mar-08	29460.25	104.7	8.085	1745309	969.26
30-Apr-08	32601.35	108.73	7.5426	1779367	909.36
31-May-08	35861.49	123.04	7.6022	1806463	890.4
30-Jun-08	34951.68	132.15	7.827	1831050	890.49
31-Jul-08	29947.75	133.86	7.32	1845063	940.47
31-Aug-08	32218.47	114.61	7.6907	1848240	839.1
30-Sep-08	26528.4	99.12	8.24	1869995	827.27
31-Oct-08	21873.23	73.26	9.7684	1891323	809.72
30-Nov-08	21783.77	53.57	10.05	1927861	759.36
31-Dec-08	21230.3	41.8	9.5251	1915400	820.34
31-Jan-09	20925.52	43.71	10.18	1928362	858.21
28-Feb-09	19105.91	43.14	10.07	1942910	941.46
31-Mar-09	20849.7	46.61	9.5744	1932543	925.13
30-Apr-09	19560.81	50.25	8.4378	1936642	891.28
31-May-09	22820.95	57.42	7.927	1951845	907.01
30-Jun-09	20469.1	68.56	7.7155	1945799	946.74
31-Jul-09	21077.15	64.77	7.7725	1948378	934.25
31-Aug-09	22215.17	72.72	7.769	1948826	949.61
30-Sep-09	21410.75	67.75	7.514	1943527	996.06
31-Oct-09	22426.7	72.84	7.809	1937953	1043.34
30-Nov-09	22047.61	76.66	7.4037	1932982	1126.58
31-Dec-09	22593.49	74.62	7.3996	1944458	1131.66
31-Jan-10	21759.51	76.46	7.617	1936251	1118.77
28-Feb-10	21376.63	73.79	7.6915	1947809	1095.61
31-Mar-10	22952.11	78.69	7.2898	1966170	1114.45
30-Apr-10	22820.95	84.7	7.3808	1975411	1148.58
31-May-10	21212.11	76.38	7.6623	1982639	1203.84
30-Jun-10	20819.37	74.74	7.6679	1999453	1232.65
31-Jul-10	21911.14	75.52	7.2882	2021478	1194.48
31-Aug-10	21293.23	77.06	7.37	2032704	1215.55
30-Sep-10	23721.65	77.66	6.9573	2040120	1271.22
31-Oct-10	23913.47	82.62	6.9843	2058330	1342.61
30-Nov-10	23905.13	85.36	7.0928	2067809	1370.84

31-Dec-10	26246.41	91.47	6.6188	2073926	1391.46
31-Jan-11	26308.8	96.27	7.1751	2092715	1360.79
28-Feb-11	28887.7	103.35	6.9615	2098516	1372.02
31-Mar-11	29692.19	114.08	6.7522	2097839	1423.08
30-Apr-11	28732.09	123.3	6.556	2097377	1477.23
31-May-11	27446.17	114.69	6.8001	2110100	1512.15
30-Jun-11	26953.81	113.83	6.7605	2123027	1528.52
31-Jul-11	25424.03	116.36	6.6861	2132764	1570.67
31-Aug-11	25626.73	110.28	6.994	2156408	1758.95
30-Sep-11	25343.94	112.83	8.0923	2173574	1776.25
31-Oct-11	27089.45	109.53	7.9497	2205791	1666.55
30-Nov-11	29447.07	111.3	8.1177	2213498	1737.48
31-Dec-11	29172.54	108.45	8.0684	2244819	1646.39
31-Jan-12	30194.15	110.97	7.79	2233508	1656.11
29-Feb-12	30258.47	119.15	7.4716	2226043	1742.86
31-Mar-12	28037.42	125.38	7.662	2235746	1674.41
30-Apr-12	27953.43	119.98	7.7659	2227122	1649.3
31-May-12	27329.87	110.41	8.5006	2246778	1584.13
30-Jun-12	25910.97	95.5	8.1393	2268502	1594.55
31-Jul-12	26072.16	102.47	8.2599	2305181	1593.35
31-Aug-12	27449.43	113.1	8.387	2319581	1627.64
30-Sep-12	28172.88	113.24	8.3048	2331166	1743.19
31-Oct-12	27999.59	112.12	8.6684	2331974	1746.68
30-Nov-12	28351.47	109.36	8.8976	2355072	1722.74
31-Dec-12	27454.73	109.94	8.3978	2370890	1686.14
31-Jan-13	29306.49	112.92	8.9597	2389998	1671.42
28-Feb-13	29049.19	116.45	9.0274	2404571	1629.14
31-Mar-13	30825.28	108.74	9.2336	2414312	1591.94
30-Apr-13	29348.86	102.47	8.9772	2441268	1485.49
31-May-13	34277.55	102.93	10.0771	2456404	1414.08
30-Jun-13	32656.6	103.19	9.8696	2468950	1342.61
31-Jul-13	34396.36	107.61	9.8532	2470270	1285.54
31-Aug-13	36462.27	111.32	10.2676	2482479	1347.3
30-Sep-13	36242.82	112.02	10.0254	2491667	1348.63
31-Oct-13	38813.48	109.26	10.0563	2494218	1315.29
30-Nov-13	38147.55	107.8	10.15	2504409	1276.62
31-Dec-13	38934.56	110.81	10.35	2520289	1222.31
31-Jan-14	40355.73	108.22	11.1079	2543919	1243.93
28-Feb-14	41323.61	108.87	10.755	2549655	1299.84
31-Mar-14	44615.45	107.63	10.5343	2600781	1336.32
30-Apr-14	44669.94	107.6	10.513	2607170	1299.09
31-May-14	45046.04	109.81	10.5711	2635665	1288.5
30-Jun-14	47853.56	112.31	10.6303	2641626	1278.3
31-Jul-14	46890.23	107.11	10.6994	2634839	1311.98
31-Aug-14	46788.07	101.79	10.6575	2639865	1295.67
30-Sep-14	46414.99	97.59	11.2794	2683913	1240.07

31-Oct-14	41559.71	87.58	11.02	2693726	1223.03
30-Nov-14	34957.86	79.49	11.037	2713708	1176.36
31-Dec-14	32615.25	62.92	11.45	2707040	1200.85
31-Jan-15	31878.94	48.24	11.629	2730248	1250.59
28-Feb-15	32067.45	57.97	11.6553	2756103	1229.14
31-Mar-15	29629.3	56.2	12.1348	2789114	1179.63
30-Apr-15	31322.4	59.31	11.7931	2820477	1198.08
31-May-15	35639.81	64.24	12.1528	2847942	1198.83
30-Jun-15	71025.66	61.78	12.1699	2868320	1181.88
31-Jul-15	11005.17	56.51	12.65	2902287	1130.81
31-Aug-15	8465.51	46.89	13.2657	2903951	1118.11
30-Sep-15	8888.79	47.71	13.8235	2909862	1124.72
31-Oct-15	9735.34	48.38	13.8	2957213	1158.18
30-Nov-15	8592.5	44.62	14.4275	2969185	1087.05

APPENDIX B: UNIT ROOTS TESTS

ADF test:

Null Hypothesis: SR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.413777	0.1405
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SR)
Method: Least Squares
Date: 09/15/17 Time: 01:53
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SR(-1)	-0.150637	0.062407	-2.413777	0.0176
C	1.529732	0.637402	2.399946	0.0182

R-squared	0.055055	Mean dependent var	-0.008029
Adjusted R-squared	0.045606	S.D. dependent var	0.210671
S.E. of regression	0.205811	Akaike info criterion	-0.304306
Sum squared resid	4.235809	Schwarz criterion	-0.252836
Log likelihood	17.51959	Hannan-Quinn criter.	-0.283464
F-statistic	5.826320	Durbin-Watson stat	2.110059
Prob(F-statistic)	0.017607		

Null Hypothesis: SR has a unit root

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.143744	0.5152
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SR)
Method: Least Squares
Date: 09/15/17 Time: 01:55
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SR(-1)	-0.140215	0.065406	-2.143744	0.0345
C	1.443970	0.658208	2.193791	0.0306
@TREND("2007M05")	-0.000401	0.000725	-0.552292	0.5820

R-squared	0.057958	Mean dependent var	-0.008029
Adjusted R-squared	0.038927	S.D. dependent var	0.210671
S.E. of regression	0.206530	Akaike info criterion	-0.287774
Sum squared resid	4.222798	Schwarz criterion	-0.210569
Log likelihood	17.67649	Hannan-Quinn criter.	-0.256511
F-statistic	3.045428	Durbin-Watson stat	2.138939
Prob(F-statistic)	0.052057		

Null Hypothesis: SR has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.460261	0.5135
Test critical values:	1% level	-2.587831	
	5% level	-1.944006	
	10% level	-1.614656	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SR)
Method: Least Squares
Date: 09/15/17 Time: 01:56
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SR(-1)	-0.000940	0.002042	-0.460261	0.6463

R-squared	0.000629	Mean dependent var	-0.008029

Adjusted R-squared	0.000629	S.D. dependent var	0.210671
S.E. of regression	0.210605	Akaike info criterion	-0.267914
Sum squared resid	4.479781	Schwarz criterion	-0.242179
Log likelihood	14.66361	Hannan-Quinn criter.	-0.257493
Durbin-Watson stat	2.319560		

PP TEST: SR

Null Hypothesis: SR has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.377544	0.1506
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Residual variance (no correction)	0.041528
HAC corrected variance (Bartlett kernel)	0.040759

Phillips-Perron Test Equation
Dependent Variable: D(SR)
Method: Least Squares
Date: 09/15/17 Time: 02:01
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SR(-1)	-0.150637	0.062407	-2.413777	0.0176
C	1.529732	0.637402	2.399946	0.0182

R-squared	0.055055	Mean dependent var	-0.008029
Adjusted R-squared	0.045606	S.D. dependent var	0.210671
S.E. of regression	0.205811	Akaike info criterion	-0.304306
Sum squared resid	4.235809	Schwarz criterion	-0.252836
Log likelihood	17.51959	Hannan-Quinn criter.	-0.283464
F-statistic	5.826320	Durbin-Watson stat	2.110059
Prob(F-statistic)	0.017607		

Null Hypothesis: SR has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.961114	0.6151
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Residual variance (no correction)	0.041400
HAC corrected variance (Bartlett kernel)	0.038092

Phillips-Perron Test Equation
Dependent Variable: D(SR)
Method: Least Squares
Date: 09/15/17 Time: 02:02
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SR(-1)	-0.140215	0.065406	-2.143744	0.0345
C	1.443970	0.658208	2.193791	0.0306
@TREND("2007M05")	-0.000401	0.000725	-0.552292	0.5820

R-squared	0.057958	Mean dependent var	-0.008029
Adjusted R-squared	0.038927	S.D. dependent var	0.210671
S.E. of regression	0.206530	Akaike info criterion	-0.287774
Sum squared resid	4.222798	Schwarz criterion	-0.210569
Log likelihood	17.67649	Hannan-Quinn criter.	-0.256511
F-statistic	3.045428	Durbin-Watson stat	2.138939
Prob(F-statistic)	0.052057		

Null Hypothesis: SR has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.507869	0.4941
Test critical values:	1% level	-2.587831	
	5% level	-1.944006	
	10% level	-1.614656	

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

Residual variance (no correction)	0.043919
HAC corrected variance (Bartlett kernel)	0.031691

Phillips-Perron Test Equation
Dependent Variable: D(SR)
Method: Least Squares
Date: 09/15/17 Time: 02:04
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SR(-1)	-0.000940	0.002042	-0.460261	0.6463

R-squared	0.000629	Mean dependent var	-0.008029

Adjusted R-squared	0.000629	S.D. dependent var	0.210671
S.E. of regression	0.210605	Akaike info criterion	-0.267914
Sum squared resid	4.479781	Schwarz criterion	-0.242179
Log likelihood	14.66361	Hannan-Quinn criter.	-0.257493
Durbin-Watson stat	2.319560		

ADF: LOILP

Null Hypothesis: LOILP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.880496	0.3402
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOILP)
Method: Least Squares
Date: 09/15/17 Time: 02:06
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOILP(-1)	-0.053393	0.028393	-1.880496	0.0630
D(LOILP(-1))	0.454491	0.092243	4.927109	0.0000
C	0.235307	0.127145	1.850703	0.0672

R-squared	0.203648	Mean dependent var	-0.004678
Adjusted R-squared	0.187396	S.D. dependent var	0.091791
S.E. of regression	0.082744	Akaike info criterion	-2.116873
Sum squared resid	0.670967	Schwarz criterion	-2.039196
Log likelihood	109.9021	Hannan-Quinn criter.	-2.085427
F-statistic	12.53061	Durbin-Watson stat	2.131002
Prob(F-statistic)	0.000014		

Null Hypothesis: LOILP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.796924	0.6991
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOILP)
Method: Least Squares
Date: 09/15/17 Time: 02:09
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOILP(-1)	-0.051237	0.028514	-1.796924	0.0755
D(LOILP(-1))	0.439739	0.093714	4.692345	0.0000
C	0.239306	0.127325	1.879498	0.0632
@TREND("2007M05")	-0.000263	0.000287	-0.915718	0.3621

R-squared	0.210474	Mean dependent var	-0.004678
Adjusted R-squared	0.186055	S.D. dependent var	0.091791
S.E. of regression	0.082812	Akaike info criterion	-2.105679
Sum squared resid	0.665216	Schwarz criterion	-2.002110
Log likelihood	110.3368	Hannan-Quinn criter.	-2.063751
F-statistic	8.619492	Durbin-Watson stat	2.119645
Prob(F-statistic)	0.000040		

Null Hypothesis: LOILP has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.513547	0.4918
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOILP)
Method: Least Squares
Date: 09/15/17 Time: 02:10
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOILP(-1)	-0.000956	0.001862	-0.513547	0.6087
D(LOILP(-1))	0.419054	0.091332	4.588237	0.0000

R-squared	0.175816	Mean dependent var	-0.004678
Adjusted R-squared	0.167491	S.D. dependent var	0.091791
S.E. of regression	0.083752	Akaike info criterion	-2.102322
Sum squared resid	0.694417	Schwarz criterion	-2.050537
Log likelihood	108.1673	Hannan-Quinn criter.	-2.081358
Durbin-Watson stat	2.083084		

PP: LOILP

Null Hypothesis: LOILP has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.733579	0.4114
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Residual variance (no correction)	0.008236
HAC corrected variance (Bartlett kernel)	0.016919

Phillips-Perron Test Equation
Dependent Variable: D(LOILP)
Method: Least Squares
Date: 09/15/17 Time: 02:11
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOILP(-1)	-0.026127	0.030670	-0.851881	0.3963
C	0.112545	0.137210	0.820238	0.4140

R-squared	0.007205	Mean dependent var	-0.004086
Adjusted R-squared	-0.002723	S.D. dependent var	0.091531
S.E. of regression	0.091655	Akaike info criterion	-1.922151
Sum squared resid	0.840069	Schwarz criterion	-1.870681
Log likelihood	100.0297	Hannan-Quinn criter.	-1.901309
F-statistic	0.725702	Durbin-Watson stat	1.135920
Prob(F-statistic)	0.396316		

Null Hypothesis: LOILP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.604833	0.7845
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Residual variance (no correction)	0.008010
HAC corrected variance (Bartlett kernel)	0.015877

Phillips-Perron Test Equation
Dependent Variable: D(LOILP)

Method: Least Squares
Date: 09/15/17 Time: 02:14
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOILP(-1)	-0.023043	0.030456	-0.756608	0.4511
C	0.125100	0.136206	0.918461	0.3606
@TREND("2007M05")	-0.000511	0.000306	-1.670062	0.0981

R-squared	0.034408	Mean dependent var	-0.004086
Adjusted R-squared	0.014901	S.D. dependent var	0.091531
S.E. of regression	0.090846	Akaike info criterion	-1.930327
Sum squared resid	0.817050	Schwarz criterion	-1.853122
Log likelihood	101.4467	Hannan-Quinn criter.	-1.899064
F-statistic	1.763896	Durbin-Watson stat	1.171301
Prob(F-statistic)	0.176719		

Null Hypothesis: LOILP has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.430496	0.5254
Test critical values:	1% level	-2.587831	
	5% level	-1.944006	
	10% level	-1.614656	

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

Residual variance (no correction)	0.008291
HAC corrected variance (Bartlett kernel)	0.016645

Phillips-Perron Test Equation
Dependent Variable: D(LOILP)
Method: Least Squares
Date: 09/15/17 Time: 02:16
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOILP(-1)	-0.001026	0.002025	-0.506399	0.6137

R-squared	0.000525	Mean dependent var	-0.004086
Adjusted R-squared	0.000525	S.D. dependent var	0.091531
S.E. of regression	0.091507	Akaike info criterion	-1.935054
Sum squared resid	0.845721	Schwarz criterion	-1.909319
Log likelihood	99.68775	Hannan-Quinn criter.	-1.924633
Durbin-Watson stat	1.156612		

ADF TEST: EXR

Null Hypothesis: EXR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.835466	0.9942
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXR)
Method: Least Squares
Date: 09/15/17 Time: 02:17
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXR(-1)	0.018190	0.021773	0.835466	0.4054
C	-0.088663	0.195873	-0.452657	0.6518

R-squared	0.006932	Mean dependent var	0.071630
Adjusted R-squared	-0.002999	S.D. dependent var	0.397723
S.E. of regression	0.398319	Akaike info criterion	1.016286
Sum squared resid	15.86580	Schwarz criterion	1.067756
Log likelihood	-49.83057	Hannan-Quinn criter.	1.037128
F-statistic	0.698004	Durbin-Watson stat	2.024247
Prob(F-statistic)	0.405447		

Null Hypothesis: EXR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.678735	0.9716
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXR)
Method: Least Squares
Date: 09/15/17 Time: 02:19
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXR(-1)	-0.022771	0.033550	-0.678735	0.4989
C	0.102645	0.228366	0.449477	0.6541
@TREND("2007M05")	0.003294	0.002064	1.595949	0.1137

R-squared	0.031840	Mean dependent var	0.071630
Adjusted R-squared	0.012281	S.D. dependent var	0.397723
S.E. of regression	0.395273	Akaike info criterion	1.010491
Sum squared resid	15.46785	Schwarz criterion	1.087696
Log likelihood	-48.53505	Hannan-Quinn criter.	1.041754
F-statistic	1.627927	Durbin-Watson stat	1.993714
Prob(F-statistic)	0.201547		

Null Hypothesis: EXR has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.954947	0.9877
Test critical values:	1% level	-2.587831	
	5% level	-1.944006	
	10% level	-1.614656	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXR)
Method: Least Squares
Date: 09/15/17 Time: 02:20
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXR(-1)	0.008537	0.004367	1.954947	0.0534

R-squared	0.004897	Mean dependent var	0.071630
Adjusted R-squared	0.004897	S.D. dependent var	0.397723
S.E. of regression	0.396748	Akaike info criterion	0.998725
Sum squared resid	15.89831	Schwarz criterion	1.024460
Log likelihood	-49.93496	Hannan-Quinn criter.	1.009146
Durbin-Watson stat	2.000927		

Null Hypothesis: EXR has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.865273	0.9947
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Residual variance (no correction)	0.155547
HAC corrected variance (Bartlett kernel)	0.152525

Phillips-Perron Test Equation
Dependent Variable: D(EXR)
Method: Least Squares
Date: 09/15/17 Time: 02:22
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXR(-1)	0.018190	0.021773	0.835466	0.4054
C	-0.088663	0.195873	-0.452657	0.6518

R-squared	0.006932	Mean dependent var	0.071630
Adjusted R-squared	-0.002999	S.D. dependent var	0.397723
S.E. of regression	0.398319	Akaike info criterion	1.016286
Sum squared resid	15.86580	Schwarz criterion	1.067756
Log likelihood	-49.83057	Hannan-Quinn criter.	1.037128
F-statistic	0.698004	Durbin-Watson stat	2.024247
Prob(F-statistic)	0.405447		

Null Hypothesis: EXR has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.701016	0.9699
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Residual variance (no correction)	0.151646
HAC corrected variance (Bartlett kernel)	0.154173

Phillips-Perron Test Equation
Dependent Variable: D(EXR)
Method: Least Squares
Date: 09/15/17 Time: 02:24
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXR(-1)	-0.022771	0.033550	-0.678735	0.4989
C	0.102645	0.228366	0.449477	0.6541
@TREND("2007M05")	0.003294	0.002064	1.595949	0.1137

R-squared	0.031840	Mean dependent var	0.071630
Adjusted R-squared	0.012281	S.D. dependent var	0.397723
S.E. of regression	0.395273	Akaike info criterion	1.010491
Sum squared resid	15.46785	Schwarz criterion	1.087696
Log likelihood	-48.53505	Hannan-Quinn criter.	1.041754
F-statistic	1.627927	Durbin-Watson stat	1.993714

Prob(F-statistic)	0.201547

Null Hypothesis: EXR has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.944601	0.9874
Test critical values:	1% level	-2.587831	
	5% level	-1.944006	
	10% level	-1.614656	

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

Residual variance (no correction)	0.155866
HAC corrected variance (Bartlett kernel)	0.157219

Phillips-Perron Test Equation
Dependent Variable: D(EXR)
Method: Least Squares
Date: 09/15/17 Time: 02:25
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXR(-1)	0.008537	0.004367	1.954947	0.0534

R-squared	0.004897	Mean dependent var	0.071630
Adjusted R-squared	0.004897	S.D. dependent var	0.397723
S.E. of regression	0.396748	Akaike info criterion	0.998725
Sum squared resid	15.89831	Schwarz criterion	1.024460
Log likelihood	-49.93496	Hannan-Quinn criter.	1.009146
Durbin-Watson stat	2.000927		

ADF: LM3

Null Hypothesis: LM3 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.315663	0.1691
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LM3)
Method: Least Squares
Date: 09/15/17 Time: 02:31
Sample (adjusted): 2007M06 2015M11

Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LM3(-1)	-0.008705	0.003759	-2.315663	0.0226
C	0.133718	0.054858	2.437555	0.0166

R-squared	0.050894	Mean dependent var	0.006695
Adjusted R-squared	0.041403	S.D. dependent var	0.006478
S.E. of regression	0.006343	Akaike info criterion	-7.263617
Sum squared resid	0.004023	Schwarz criterion	-7.212147
Log likelihood	372.4445	Hannan-Quinn criter.	-7.242775
F-statistic	5.362296	Durbin-Watson stat	1.514994
Prob(F-statistic)	0.022619		

Null Hypothesis: LM3 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.906234	0.0152
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LM3)
Method: Least Squares
Date: 09/15/17 Time: 02:34
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LM3(-1)	-0.094912	0.024298	-3.906234	0.0002
C	1.366203	0.347533	3.931148	0.0002
@TREND("2007M05")	0.000494	0.000138	3.586551	0.0005

R-squared	0.160033	Mean dependent var	0.006695
Adjusted R-squared	0.143064	S.D. dependent var	0.006478
S.E. of regression	0.005997	Akaike info criterion	-7.366168
Sum squared resid	0.003560	Schwarz criterion	-7.288963
Log likelihood	378.6745	Hannan-Quinn criter.	-7.334905
F-statistic	9.430896	Durbin-Watson stat	1.571799
Prob(F-statistic)	0.000178		

Null Hypothesis: LM3 has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		10.38232	1.0000
Test critical values:	1% level	-2.587831	

	5% level	-1.944006	
	10% level	-1.614656	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LM3)
Method: Least Squares
Date: 09/15/17 Time: 02:37
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LM3(-1)	0.000458	4.41E-05	10.38232	0.0000

R-squared	-0.005499	Mean dependent var	0.006695
Adjusted R-squared	-0.005499	S.D. dependent var	0.006478
S.E. of regression	0.006496	Akaike info criterion	-7.225507
Sum squared resid	0.004262	Schwarz criterion	-7.199772
Log likelihood	369.5008	Hannan-Quinn criter.	-7.215086
Durbin-Watson stat	1.443573		

PP: LM3

Null Hypothesis: LM3 has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.657102	0.4499
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Residual variance (no correction)	3.94E-05
HAC corrected variance (Bartlett kernel)	9.63E-05

Phillips-Perron Test Equation
Dependent Variable: D(LM3)
Method: Least Squares
Date: 09/15/17 Time: 02:51
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LM3(-1)	-0.008705	0.003759	-2.315663	0.0226
C	0.133718	0.054858	2.437555	0.0166

R-squared	0.050894	Mean dependent var	0.006695
Adjusted R-squared	0.041403	S.D. dependent var	0.006478
S.E. of regression	0.006343	Akaike info criterion	-7.263617
Sum squared resid	0.004023	Schwarz criterion	-7.212147
Log likelihood	372.4445	Hannan-Quinn criter.	-7.242775

F-statistic	5.362296	Durbin-Watson stat	1.514994
Prob(F-statistic)	0.022619		

Null Hypothesis: LM3 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.622237	0.0328
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Residual variance (no correction)	3.49E-05
HAC corrected variance (Bartlett kernel)	8.04E-05

Phillips-Perron Test Equation
Dependent Variable: D(LM3)
Method: Least Squares
Date: 09/15/17 Time: 02:53
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LM3(-1)	-0.094912	0.024298	-3.906234	0.0002
C	1.366203	0.347533	3.931148	0.0002
@TREND("2007M05")	0.000494	0.000138	3.586551	0.0005

R-squared	0.160033	Mean dependent var	0.006695
Adjusted R-squared	0.143064	S.D. dependent var	0.006478
S.E. of regression	0.005997	Akaike info criterion	-7.366168
Sum squared resid	0.003560	Schwarz criterion	-7.288963
Log likelihood	378.6745	Hannan-Quinn criter.	-7.334905
F-statistic	9.430896	Durbin-Watson stat	1.571799
Prob(F-statistic)	0.000178		

Null Hypothesis: LM3 has a unit root
Exogenous: None
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		6.474112	1.0000
Test critical values:	1% level	-2.587831	
	5% level	-1.944006	
	10% level	-1.614656	

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

Residual variance (no correction)	4.18E-05

HAC corrected variance (Bartlett kernel)	0.000107

Phillips-Perron Test Equation
Dependent Variable: D(LM3)
Method: Least Squares
Date: 09/15/17 Time: 02:57
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LM3(-1)	0.000458	4.41E-05	10.38232	0.0000

R-squared	-0.005499	Mean dependent var	0.006695
Adjusted R-squared	-0.005499	S.D. dependent var	0.006478
S.E. of regression	0.006496	Akaike info criterion	-7.225507
Sum squared resid	0.004262	Schwarz criterion	-7.199772
Log likelihood	369.5008	Hannan-Quinn criter.	-7.215086
Durbin-Watson stat	1.443573		

ADF: LGP
Null Hypothesis: LGP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.353641	0.1576
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGP)
Method: Least Squares
Date: 09/15/17 Time: 03:00
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGP(-1)	-0.035796	0.015209	-2.353641	0.0205
C	0.258248	0.107764	2.396420	0.0184

R-squared	0.052489	Mean dependent var	0.004782
Adjusted R-squared	0.043013	S.D. dependent var	0.040969
S.E. of regression	0.040078	Akaike info criterion	-3.576564
Sum squared resid	0.160625	Schwarz criterion	-3.525094
Log likelihood	184.4048	Hannan-Quinn criter.	-3.555722
F-statistic	5.539624	Durbin-Watson stat	1.611283
Prob(F-statistic)	0.020546		

Null Hypothesis: LGP has a unit root

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.683367	0.9712
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGP)
Method: Least Squares
Date: 09/15/17 Time: 03:02
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGP(-1)	-0.013344	0.019527	-0.683367	0.4960
C	0.115337	0.132820	0.868368	0.3873
@TREND("2007M05")	-0.000312	0.000173	-1.802850	0.0745

R-squared	0.082607	Mean dependent var	0.004782
Adjusted R-squared	0.064074	S.D. dependent var	0.040969
S.E. of regression	0.039635	Akaike info criterion	-3.589260
Sum squared resid	0.155519	Schwarz criterion	-3.512055
Log likelihood	186.0523	Hannan-Quinn criter.	-3.557997
F-statistic	4.457274	Durbin-Watson stat	1.701068
Prob(F-statistic)	0.014011		

Null Hypothesis: LGP has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.092230	0.9278
Test critical values:	1% level	-2.587831	
	5% level	-1.944006	
	10% level	-1.614656	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGP)
Method: Least Squares
Date: 09/15/17 Time: 03:03
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGP(-1)	0.000626	0.000573	1.092230	0.2773

R-squared	-0.001925	Mean dependent var	0.004782

Adjusted R-squared	-0.001925	S.D. dependent var	0.040969
S.E. of regression	0.041008	Akaike info criterion	-3.540332
Sum squared resid	0.169849	Schwarz criterion	-3.514597
Log likelihood	181.5570	Hannan-Quinn criter.	-3.529911
Durbin-Watson stat	1.579199		

Null Hypothesis: LGP has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.277052	0.1814
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

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

Residual variance (no correction)	0.001575
HAC corrected variance (Bartlett kernel)	0.001967

Phillips-Perron Test Equation
Dependent Variable: D(LGP)
Method: Least Squares
Date: 09/15/17 Time: 03:04
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGP(-1)	-0.035796	0.015209	-2.353641	0.0205
C	0.258248	0.107764	2.396420	0.0184

R-squared	0.052489	Mean dependent var	0.004782
Adjusted R-squared	0.043013	S.D. dependent var	0.040969
S.E. of regression	0.040078	Akaike info criterion	-3.576564
Sum squared resid	0.160625	Schwarz criterion	-3.525094
Log likelihood	184.4048	Hannan-Quinn criter.	-3.555722
F-statistic	5.539624	Durbin-Watson stat	1.611283
Prob(F-statistic)	0.020546		

Null Hypothesis: LGP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.739907	0.9669
Test critical values:	1% level	-4.050509	
	5% level	-3.454471	
	10% level	-3.152909	

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

Residual variance (no correction)	0.001525
HAC corrected variance (Bartlett kernel)	0.001664

Phillips-Perron Test Equation
Dependent Variable: D(LGP)
Method: Least Squares
Date: 09/15/17 Time: 03:06
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGP(-1)	-0.013344	0.019527	-0.683367	0.4960
C	0.115337	0.132820	0.868368	0.3873
@TREND("2007M05")	-0.000312	0.000173	-1.802850	0.0745

R-squared	0.082607	Mean dependent var	0.004782
Adjusted R-squared	0.064074	S.D. dependent var	0.040969
S.E. of regression	0.039635	Akaike info criterion	-3.589260
Sum squared resid	0.155519	Schwarz criterion	-3.512055
Log likelihood	186.0523	Hannan-Quinn criter.	-3.557997
F-statistic	4.457274	Durbin-Watson stat	1.701068
Prob(F-statistic)	0.014011		

Null Hypothesis: LGP has a unit root
Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.936583	0.9062
Test critical values:	1% level	-2.587831	
	5% level	-1.944006	
	10% level	-1.614656	

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

Residual variance (no correction)	0.001665
HAC corrected variance (Bartlett kernel)	0.002224

Phillips-Perron Test Equation
Dependent Variable: D(LGP)
Method: Least Squares
Date: 09/15/17 Time: 03:07
Sample (adjusted): 2007M06 2015M11
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGP(-1)	0.000626	0.000573	1.092230	0.2773

R-squared	-0.001925	Mean dependent var	0.004782
Adjusted R-squared	-0.001925	S.D. dependent var	0.040969
S.E. of regression	0.041008	Akaike info criterion	-3.540332

Sum squared resid	0.169849	Schwarz criterion	-3.514597
Log likelihood	181.5570	Hannan-Quinn criter.	-3.529911
Durbin-Watson stat	1.579199		

ADF: Differentiated SR

Null Hypothesis: D(SR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.70461	0.0001
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:23
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SR(-1))	-1.162349	0.099307	-11.70461	0.0000
C	-0.009563	0.020900	-0.457560	0.6483

R-squared	0.580505	Mean dependent var	-0.001575
Adjusted R-squared	0.576267	S.D. dependent var	0.322500
S.E. of regression	0.209931	Akaike info criterion	-0.264476
Sum squared resid	4.363016	Schwarz criterion	-0.212691
Log likelihood	15.35604	Hannan-Quinn criter.	-0.243512
F-statistic	136.9978	Durbin-Watson stat	2.038395
Prob(F-statistic)	0.000000		

Null Hypothesis: D(SR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.83941	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:27
Sample (adjusted): 2007M07 2015M11

Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SR(-1))	-1.177708	0.099474	-11.83941	0.0000
C	0.041956	0.042660	0.983501	0.3278
@TREND("2007M05")	-0.000993	0.000718	-1.383316	0.1697

R-squared	0.588539	Mean dependent var	-0.001575
Adjusted R-squared	0.580142	S.D. dependent var	0.322500
S.E. of regression	0.208969	Akaike info criterion	-0.264012
Sum squared resid	4.279454	Schwarz criterion	-0.186335
Log likelihood	16.33260	Hannan-Quinn criter.	-0.232566
F-statistic	70.08778	Durbin-Watson stat	2.051440
Prob(F-statistic)	0.000000		

Null Hypothesis: D(SR) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.74241	0.0000
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:29
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SR(-1))	-1.160865	0.098861	-11.74241	0.0000

R-squared	0.579617	Mean dependent var	-0.001575
Adjusted R-squared	0.579617	S.D. dependent var	0.322500
S.E. of regression	0.209099	Akaike info criterion	-0.282165
Sum squared resid	4.372242	Schwarz criterion	-0.256273
Log likelihood	15.24936	Hannan-Quinn criter.	-0.271684
Durbin-Watson stat	2.036678		

PP: Differentiated SR

Null Hypothesis: D(SR) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-11.72363	0.0001

Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Residual variance (no correction)	0.043198
HAC corrected variance (Bartlett kernel)	0.042312

Phillips-Perron Test Equation
Dependent Variable: D(SR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:30
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SR(-1))	-1.162349	0.099307	-11.70461	0.0000
C	-0.009563	0.020900	-0.457560	0.6483

R-squared	0.580505	Mean dependent var	-0.001575
Adjusted R-squared	0.576267	S.D. dependent var	0.322500
S.E. of regression	0.209931	Akaike info criterion	-0.264476
Sum squared resid	4.363016	Schwarz criterion	-0.212691
Log likelihood	15.35604	Hannan-Quinn criter.	-0.243512
F-statistic	136.9978	Durbin-Watson stat	2.038395
Prob(F-statistic)	0.000000		

Null Hypothesis: D(SR) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.27345	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Residual variance (no correction)	0.042371
HAC corrected variance (Bartlett kernel)	0.031255

Phillips-Perron Test Equation
Dependent Variable: D(SR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:33
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SR(-1))	-1.177708	0.099474	-11.83941	0.0000
C	0.041956	0.042660	0.983501	0.3278
@TREND("2007M05")	-0.000993	0.000718	-1.383316	0.1697

R-squared	0.588539	Mean dependent var	-0.001575
Adjusted R-squared	0.580142	S.D. dependent var	0.322500
S.E. of regression	0.208969	Akaike info criterion	-0.264012
Sum squared resid	4.279454	Schwarz criterion	-0.186335
Log likelihood	16.33260	Hannan-Quinn criter.	-0.232566
F-statistic	70.08778	Durbin-Watson stat	2.051440
Prob(F-statistic)	0.000000		

Null Hypothesis: D(SR) has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-11.76109	0.0000
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Residual variance (no correction)	0.043290
HAC corrected variance (Bartlett kernel)	0.042432

Phillips-Perron Test Equation
Dependent Variable: D(SR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:34
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SR(-1))	-1.160865	0.098861	-11.74241	0.0000

R-squared	0.579617	Mean dependent var	-0.001575
Adjusted R-squared	0.579617	S.D. dependent var	0.322500
S.E. of regression	0.209099	Akaike info criterion	-0.282165
Sum squared resid	4.372242	Schwarz criterion	-0.256273
Log likelihood	15.24936	Hannan-Quinn criter.	-0.271684
Durbin-Watson stat	2.036678		

ADF TEST: Differentiated loilp

Null Hypothesis: D(LOILP) has a unit root
Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.357426	0.0000
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOILP,2)
Method: Least Squares
Date: 09/15/17 Time: 03:41
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOILP(-1))	-0.581191	0.091419	-6.357426	0.0000
C	-0.003286	0.008344	-0.393771	0.6946

R-squared	0.289899	Mean dependent var	-0.001353
Adjusted R-squared	0.282727	S.D. dependent var	0.098944
S.E. of regression	0.083797	Akaike info criterion	-2.101227
Sum squared resid	0.695178	Schwarz criterion	-2.049442
Log likelihood	108.1119	Hannan-Quinn criter.	-2.080263
F-statistic	40.41687	Durbin-Watson stat	2.082169
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LOILP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.448033	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOILP,2)
Method: Least Squares
Date: 09/15/17 Time: 03:45
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOILP(-1))	-0.596659	0.092534	-6.448033	0.0000
C	0.012556	0.017166	0.731446	0.4663
@TREND("2007M05")	-0.000306	0.000289	-1.055788	0.2937

R-squared	0.297886	Mean dependent var	-0.001353

Adjusted R-squared	0.283557	S.D. dependent var	0.098944
S.E. of regression	0.083749	Akaike info criterion	-2.092735
Sum squared resid	0.687360	Schwarz criterion	-2.015058
Log likelihood	108.6831	Hannan-Quinn criter.	-2.061289
F-statistic	20.78919	Durbin-Watson stat	2.071722
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LOILP) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.374281	0.0000
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOILP,2)
Method: Least Squares
Date: 09/15/17 Time: 03:46
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOILP(-1))	-0.579880	0.090972	-6.374281	0.0000

R-squared	0.288787	Mean dependent var	-0.001353
Adjusted R-squared	0.288787	S.D. dependent var	0.098944
S.E. of regression	0.083443	Akaike info criterion	-2.119464
Sum squared resid	0.696267	Schwarz criterion	-2.093571
Log likelihood	108.0329	Hannan-Quinn criter.	-2.108982
Durbin-Watson stat	2.081791		

PP TEST: Differentiated loilp
Null Hypothesis: D(LOILP) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.389188	0.0000
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Residual variance (no correction)	0.006883
HAC corrected variance (Bartlett kernel)	0.007040

Phillips-Perron Test Equation
Dependent Variable: D(LOILP,2)
Method: Least Squares
Date: 09/15/17 Time: 03:48
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOILP(-1))	-0.581191	0.091419	-6.357426	0.0000
C	-0.003286	0.008344	-0.393771	0.6946

R-squared	0.289899	Mean dependent var	-0.001353
Adjusted R-squared	0.282727	S.D. dependent var	0.098944
S.E. of regression	0.083797	Akaike info criterion	-2.101227
Sum squared resid	0.695178	Schwarz criterion	-2.049442
Log likelihood	108.1119	Hannan-Quinn criter.	-2.080263
F-statistic	40.41687	Durbin-Watson stat	2.082169
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LOILP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.489631	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Residual variance (no correction)	0.006806
HAC corrected variance (Bartlett kernel)	0.007010

Phillips-Perron Test Equation
Dependent Variable: D(LOILP,2)
Method: Least Squares
Date: 09/15/17 Time: 03:49
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOILP(-1))	-0.596659	0.092534	-6.448033	0.0000
C	0.012556	0.017166	0.731446	0.4663
@TREND("2007M05")	-0.000306	0.000289	-1.055788	0.2937

R-squared	0.297886	Mean dependent var	-0.001353
Adjusted R-squared	0.283557	S.D. dependent var	0.098944
S.E. of regression	0.083749	Akaike info criterion	-2.092735
Sum squared resid	0.687360	Schwarz criterion	-2.015058
Log likelihood	108.6831	Hannan-Quinn criter.	-2.061289
F-statistic	20.78919	Durbin-Watson stat	2.071722
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LOILP) has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.406344	0.0000
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Residual variance (no correction)	0.006894
HAC corrected variance (Bartlett kernel)	0.007053

Phillips-Perron Test Equation
Dependent Variable: D(LOILP,2)
Method: Least Squares
Date: 09/15/17 Time: 03:50
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOILP(-1))	-0.579880	0.090972	-6.374281	0.0000

R-squared	0.288787	Mean dependent var	-0.001353
Adjusted R-squared	0.288787	S.D. dependent var	0.098944
S.E. of regression	0.083443	Akaike info criterion	-2.119464
Sum squared resid	0.696267	Schwarz criterion	-2.093571
Log likelihood	108.0329	Hannan-Quinn criter.	-2.108982
Durbin-Watson stat	2.081791		

ADF TEST: DIFFERENTIATED EXR

Null Hypothesis: D(EXR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.835317	0.0000
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:55

Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXR(-1))	-0.997523	0.101423	-9.835317	0.0000
C	0.073001	0.040501	1.802422	0.0745

R-squared	0.494210	Mean dependent var	0.007038
Adjusted R-squared	0.489101	S.D. dependent var	0.561598
S.E. of regression	0.401414	Akaike info criterion	1.031958
Sum squared resid	15.95221	Schwarz criterion	1.083742
Log likelihood	-50.11386	Hannan-Quinn criter.	1.052922
F-statistic	96.73346	Durbin-Watson stat	1.981261
Prob(F-statistic)	0.000000		

Null Hypothesis: D(EXR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.04903	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:57
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXR(-1))	-1.021562	0.101658	-10.04903	0.0000
C	-0.041849	0.081079	-0.516154	0.6069
@TREND("2007M05")	0.002239	0.001373	1.630678	0.1062

R-squared	0.507572	Mean dependent var	0.007038
Adjusted R-squared	0.497522	S.D. dependent var	0.561598
S.E. of regression	0.398092	Akaike info criterion	1.024987
Sum squared resid	15.53080	Schwarz criterion	1.102664
Log likelihood	-48.76186	Hannan-Quinn criter.	1.056433
F-statistic	50.50685	Durbin-Watson stat	1.985640
Prob(F-statistic)	0.000000		

Null Hypothesis: D(EXR) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-9.563426	0.0000

Test critical values:	1% level	-2.588059
	5% level	-1.944039
	10% level	-1.614637

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:58
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXR(-1))	-0.967252	0.101141	-9.563426	0.0000

R-squared	0.477612	Mean dependent var	0.007038
Adjusted R-squared	0.477612	S.D. dependent var	0.561598
S.E. of regression	0.405903	Akaike info criterion	1.044444
Sum squared resid	16.47568	Schwarz criterion	1.070336
Log likelihood	-51.74443	Hannan-Quinn criter.	1.054926
Durbin-Watson stat	1.979876		

PP TEST: DIFFERENTIATED EXR

Null Hypothesis: D(EXR) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.840535	0.0000
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Residual variance (no correction)	0.157943
HAC corrected variance (Bartlett kernel)	0.162401

Phillips-Perron Test Equation
Dependent Variable: D(EXR,2)
Method: Least Squares
Date: 09/15/17 Time: 03:59
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXR(-1))	-0.997523	0.101423	-9.835317	0.0000
C	0.073001	0.040501	1.802422	0.0745

R-squared	0.494210	Mean dependent var	0.007038
Adjusted R-squared	0.489101	S.D. dependent var	0.561598

S.E. of regression	0.401414	Akaike info criterion	1.031958
Sum squared resid	15.95221	Schwarz criterion	1.083742
Log likelihood	-50.11386	Hannan-Quinn criter.	1.052922
F-statistic	96.73346	Durbin-Watson stat	1.981261
Prob(F-statistic)	0.000000		

Null Hypothesis: D(EXR) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-10.04905	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Residual variance (no correction)	0.153770
HAC corrected variance (Bartlett kernel)	0.153873

Phillips-Perron Test Equation
Dependent Variable: D(EXR,2)
Method: Least Squares
Date: 09/15/17 Time: 04:01
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXR(-1))	-1.021562	0.101658	-10.04903	0.0000
C	-0.041849	0.081079	-0.516154	0.6069
@TREND("2007M05")	0.002239	0.001373	1.630678	0.1062

R-squared	0.507572	Mean dependent var	0.007038
Adjusted R-squared	0.497522	S.D. dependent var	0.561598
S.E. of regression	0.398092	Akaike info criterion	1.024987
Sum squared resid	15.53080	Schwarz criterion	1.102664
Log likelihood	-48.76186	Hannan-Quinn criter.	1.056433
F-statistic	50.50685	Durbin-Watson stat	1.985640
Prob(F-statistic)	0.000000		

Null Hypothesis: D(EXR) has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.624374	0.0000
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Residual variance (no correction)	0.163126
HAC corrected variance (Bartlett kernel)	0.186268

Phillips-Perron Test Equation
Dependent Variable: D(EXR,2)
Method: Least Squares
Date: 09/15/17 Time: 04:02
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXR(-1))	-0.967252	0.101141	-9.563426	0.0000

R-squared	0.477612	Mean dependent var	0.007038
Adjusted R-squared	0.477612	S.D. dependent var	0.561598
S.E. of regression	0.405903	Akaike info criterion	1.044444
Sum squared resid	16.47568	Schwarz criterion	1.070336
Log likelihood	-51.74443	Hannan-Quinn criter.	1.054926
Durbin-Watson stat	1.979876		

ADF TEST: DIFFERENTIATED LGP

Null Hypothesis: D(LGP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.022509	0.0000
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGP,2)
Method: Least Squares
Date: 09/15/17 Time: 04:04
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGP(-1))	-0.800419	0.099772	-8.022509	0.0000
C	0.003918	0.004067	0.963212	0.3378

R-squared	0.393979	Mean dependent var	-0.000450
Adjusted R-squared	0.387857	S.D. dependent var	0.051773
S.E. of regression	0.040507	Akaike info criterion	-3.555101
Sum squared resid	0.162438	Schwarz criterion	-3.503316
Log likelihood	181.5326	Hannan-Quinn criter.	-3.534137
F-statistic	64.36065	Durbin-Watson stat	1.965745

Prob(F-statistic)	0.000000

Null Hypothesis: D(LGP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.657160	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGP,2)
Method: Least Squares
Date: 09/15/17 Time: 04:16
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGP(-1))	-0.868650	0.100339	-8.657160	0.0000
C	0.023290	0.008363	2.784783	0.0064
@TREND("2007M05")	-0.000365	0.000139	-2.628125	0.0100

R-squared	0.433879	Mean dependent var	-0.000450
Adjusted R-squared	0.422326	S.D. dependent var	0.051773
S.E. of regression	0.039350	Akaike info criterion	-3.603406
Sum squared resid	0.151743	Schwarz criterion	-3.525729
Log likelihood	184.9720	Hannan-Quinn criter.	-3.571960
F-statistic	37.55395	Durbin-Watson stat	1.970795
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LGP) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.968137	0.0000
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGP,2)
Method: Least Squares
Date: 09/15/17 Time: 04:07
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGP(-1))	-0.787554	0.098838	-7.968137	0.0000

R-squared	0.388300	Mean dependent var	-0.000450
Adjusted R-squared	0.388300	S.D. dependent var	0.051773
S.E. of regression	0.040492	Akaike info criterion	-3.565575
Sum squared resid	0.163960	Schwarz criterion	-3.539683
Log likelihood	181.0615	Hannan-Quinn criter.	-3.555093
Durbin-Watson stat	1.972384		

Null Hypothesis: D(LGP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.657160	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGP,2)
Method: Least Squares
Date: 09/15/17 Time: 04:09
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGP(-1))	-0.868650	0.100339	-8.657160	0.0000
C	0.023290	0.008363	2.784783	0.0064
@TREND("2007M05")	-0.000365	0.000139	-2.628125	0.0100

R-squared	0.433879	Mean dependent var	-0.000450
Adjusted R-squared	0.422326	S.D. dependent var	0.051773
S.E. of regression	0.039350	Akaike info criterion	-3.603406
Sum squared resid	0.151743	Schwarz criterion	-3.525729
Log likelihood	184.9720	Hannan-Quinn criter.	-3.571960
F-statistic	37.55395	Durbin-Watson stat	1.970795
Prob(F-statistic)	0.000000		

ADF TEST: DIFFERENTIATED LM3

Null Hypothesis: D(LM3) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.653431	0.0000
Test critical values:	1% level	-3.496346	

	5% level	-2.890327
	10% level	-2.582196

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LM3,2)
Method: Least Squares
Date: 09/15/17 Time: 04:42
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LM3(-1))	-0.734918	0.096025	-7.653431	0.0000
C	0.004826	0.000896	5.385963	0.0000

R-squared	0.371728	Mean dependent var	-0.000114
Adjusted R-squared	0.365382	S.D. dependent var	0.007841
S.E. of regression	0.006246	Akaike info criterion	-7.294005
Sum squared resid	0.003863	Schwarz criterion	-7.242220
Log likelihood	370.3472	Hannan-Quinn criter.	-7.273041
F-statistic	58.57501	Durbin-Watson stat	2.120974
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LM3) has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.102292	0.0022
Test critical values:	1% level	-2.588292	
	5% level	-1.944072	
	10% level	-1.614616	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LM3,2)
Method: Least Squares
Date: 09/15/17 Time: 04:45
Sample (adjusted): 2007M08 2015M11
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LM3(-1))	-0.240569	0.077546	-3.102292	0.0025
D(LM3(-1),2)	-0.392370	0.092564	-4.238896	0.0001

R-squared	0.323593	Mean dependent var	-0.000149
Adjusted R-squared	0.316691	S.D. dependent var	0.007873
S.E. of regression	0.006508	Akaike info criterion	-7.211840
Sum squared resid	0.004150	Schwarz criterion	-7.159737
Log likelihood	362.5920	Hannan-Quinn criter.	-7.190753
Durbin-Watson stat	2.216695		

PP TEST: DIFFERENTIATED LM3

Null Hypothesis: D(LM3) has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.025927	0.0000
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Residual variance (no correction)	3.82E-05
HAC corrected variance (Bartlett kernel)	5.14E-05

Phillips-Perron Test Equation
Dependent Variable: D(LM3,2)
Method: Least Squares
Date: 09/15/17 Time: 04:47
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LM3(-1))	-0.734918	0.096025	-7.653431	0.0000
C	0.004826	0.000896	5.385963	0.0000

R-squared	0.371728	Mean dependent var	-0.000114
Adjusted R-squared	0.365382	S.D. dependent var	0.007841
S.E. of regression	0.006246	Akaike info criterion	-7.294005
Sum squared resid	0.003863	Schwarz criterion	-7.242220
Log likelihood	370.3472	Hannan-Quinn criter.	-7.273041
F-statistic	58.57501	Durbin-Watson stat	2.120974
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LM3) has a unit root
Exogenous: None
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.022264	0.0000
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Residual variance (no correction)	4.95E-05
HAC corrected variance (Bartlett kernel)	5.72E-05

Phillips-Perron Test Equation
Dependent Variable: D(LM3,2)
Method: Least Squares
Date: 09/15/17 Time: 04:49
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LM3(-1))	-0.362391	0.075362	-4.808671	0.0000

R-squared	0.187634	Mean dependent var	-0.000114
Adjusted R-squared	0.187634	S.D. dependent var	0.007841
S.E. of regression	0.007067	Akaike info criterion	-7.056829
Sum squared resid	0.004995	Schwarz criterion	-7.030937
Log likelihood	357.3699	Hannan-Quinn criter.	-7.046347
Durbin-Watson stat	2.503940		

PP TEST: DIFFERENTIATED LGP

Null Hypothesis: D(LGP) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.022509	0.0000
Test critical values:	1% level	-3.496346	
	5% level	-2.890327	
	10% level	-2.582196	

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

Residual variance (no correction)	0.001608
HAC corrected variance (Bartlett kernel)	0.001608

Phillips-Perron Test Equation
Dependent Variable: D(LGP,2)
Method: Least Squares
Date: 09/15/17 Time: 04:12
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGP(-1))	-0.800419	0.099772	-8.022509	0.0000
C	0.003918	0.004067	0.963212	0.3378

R-squared	0.393979	Mean dependent var	-0.000450
Adjusted R-squared	0.387857	S.D. dependent var	0.051773
S.E. of regression	0.040507	Akaike info criterion	-3.555101
Sum squared resid	0.162438	Schwarz criterion	-3.503316
Log likelihood	181.5326	Hannan-Quinn criter.	-3.534137

F-statistic	64.36065	Durbin-Watson stat	1.965745
Prob(F-statistic)	0.000000		

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.597968	0.0000
Test critical values:	1% level	-4.051450	
	5% level	-3.454919	
	10% level	-3.153171	

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

Residual variance (no correction)	0.001502
HAC corrected variance (Bartlett kernel)	0.001348

Phillips-Perron Test Equation
Dependent Variable: D(LGP,2)
Method: Least Squares
Date: 09/15/17 Time: 04:18
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGP(-1))	-0.868650	0.100339	-8.657160	0.0000
C	0.023290	0.008363	2.784783	0.0064
@TREND("2007M05")	-0.000365	0.000139	-2.628125	0.0100

R-squared	0.433879	Mean dependent var	-0.000450
Adjusted R-squared	0.422326	S.D. dependent var	0.051773
S.E. of regression	0.039350	Akaike info criterion	-3.603406
Sum squared resid	0.151743	Schwarz criterion	-3.525729
Log likelihood	184.9720	Hannan-Quinn criter.	-3.571960
F-statistic	37.55395	Durbin-Watson stat	1.970795
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LGP) has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.966167	0.0000
Test critical values:	1% level	-2.588059	
	5% level	-1.944039	
	10% level	-1.614637	

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

Residual variance (no correction)	0.001623

HAC corrected variance (Bartlett kernel)	0.001620

Phillips-Perron Test Equation
Dependent Variable: D(LGP,2)
Method: Least Squares
Date: 09/15/17 Time: 04:19
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGP(-1))	-0.787554	0.098838	-7.968137	0.0000

R-squared	0.388300	Mean dependent var	-0.000450
Adjusted R-squared	0.388300	S.D. dependent var	0.051773
S.E. of regression	0.040492	Akaike info criterion	-3.565575
Sum squared resid	0.163960	Schwarz criterion	-3.539683
Log likelihood	181.0615	Hannan-Quinn criter.	-3.555093
Durbin-Watson stat	1.972384		

APPENDIX C: GARCH MODEL RESULTS

Dependent Variable: OILGAS
Method: ML ARCH - Generalized error distribution (GED) (BFGS / Marquardt steps)
Date: 01/27/18 Time: 13:26
Sample: 2007M06 2015M11
Included observations: 102
Failure to improve likelihood (non-zero gradients) after 33 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(7) + C(8)*RESID(-1)^2 + C(9)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	-0.908489	0.420565	-2.160165	0.0308
OILP	0.534053	0.034620	15.42601	0.0000
EXR	-0.172949	0.051190	-3.378571	0.0007
M3	0.579212	0.326326	1.774951	0.0759
GP	-0.381880	0.053656	-7.117130	0.0000
C	0.202768	0.131425	1.542836	0.1229
	Variance Equation			
C	0.028513	0.023070	1.235969	0.2165
RESID(-1)^2	0.052018	0.014470	3.594826	0.0003
GARCH(-1)	0.478996	0.204113	2.346723	0.0189
GED PARAMETER	0.385630	0.069623	5.538795	0.0000

R-squared	0.066629	Mean dependent var	-0.008029
Adjusted R-squared	0.018016	S.D. dependent var	0.210671
S.E. of regression	0.208764	Akaike info criterion	-1.699918
Sum squared resid	4.183929	Schwarz criterion	-1.442568
Log likelihood	96.69584	Hannan-Quinn criter.	-1.595709
Durbin-Watson stat	2.654865		

APPENDIX D: JOHANSEN-COINTEGRATION RESULTS

Date: 10/18/17 Time: 17:23
Sample (adjusted): 2007M07 2015M11
Included observations: 101 after adjustments
Trend assumption: Linear deterministic trend
Series: SR LOILP EXR LM3 LGP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.229114	71.16507	69.81889	0.0389
At most 1	0.174588	44.88344	47.85613	0.0926
At most 2	0.150888	25.50432	29.79707	0.1442
At most 3	0.084699	8.984385	15.49471	0.3668
At most 4	0.000452	0.045667	3.841466	0.8308

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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.229114	26.28163	33.87687	0.3038
At most 1	0.174588	19.37912	27.58434	0.3858
At most 2	0.150888	16.51994	21.13162	0.1959
At most 3	0.084699	8.938718	14.26460	0.2913
At most 4	0.000452	0.045667	3.841466	0.8308

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

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

SR	LOILP	EXR	LM3	LGP
2.654294	-3.433912	1.626795	-25.61996	10.15344
1.006188	-3.436844	-0.905429	5.295484	-2.857844
0.621975	-4.133900	-1.129907	12.72111	0.283885
3.292080	-1.430730	-0.361575	6.806076	-3.439900
2.380139	-0.763492	-0.322784	-3.119199	2.504168

Unrestricted Adjustment Coefficients (alpha):

D(SR)	-0.008486	-0.010745	-0.020864	-0.054542	0.001119
D(LOILP)	0.013758	0.007275	0.014256	-0.013142	-0.000716
D(EXR)	-0.146437	-0.058510	0.003972	0.018610	-0.003701
D(LM3)	0.000230	5.31E-05	-0.001701	3.32E-05	-8.76E-05
D(LGP)	-0.006662	0.015111	0.001420	-0.002192	0.000108

1 Cointegrating Equation(s): Log likelihood 669.7628

Normalized cointegrating coefficients (standard error in parentheses)

SR	LOILP	EXR	LM3	LGP
1.000000	-1.293720	0.612892	-9.652271	3.825289
	(0.35279)	(0.15867)	(2.06445)	(0.76486)

Adjustment coefficients (standard error in parentheses)

D(SR)	-0.022524
	(0.05589)
D(LOILP)	0.036517
	(0.02023)
D(EXR)	-0.388688
	(0.09728)
D(LM3)	0.000611
	(0.00165)
D(LGP)	-0.017682
	(0.01079)

2 Cointegrating Equation(s): Log likelihood 679.4523

Normalized cointegrating coefficients (standard error in parentheses)

SR	LOILP	EXR	LM3	LGP
1.000000	0.000000	1.535176	-18.74566	7.889100
		(0.37408)	(5.07386)	(1.89269)
0.000000	1.000000	0.712894	-7.028870	3.141183
		(0.23196)	(3.14613)	(1.17359)

Adjustment coefficients (standard error in parentheses)

D(SR)	-0.033335	0.066069
	(0.05969)	(0.10216)
D(LOILP)	0.043837	-0.072246
	(0.02153)	(0.03685)
D(EXR)	-0.447560	0.703942
	(0.10261)	(0.17562)
D(LM3)	0.000664	-0.000973
	(0.00177)	(0.00302)
D(LGP)	-0.002477	-0.029060
	(0.01066)	(0.01824)

3 Cointegrating Equation(s): Log likelihood 687.7123

Normalized cointegrating coefficients (standard error in parentheses)

SR	LOILP	EXR	LM3	LGP
1.000000	0.000000	0.000000	-10.42030	-6.999015
			(5.36150)	(3.32549)
0.000000	1.000000	0.000000	-3.162806	-3.772446
			(2.25233)	(1.39702)
0.000000	0.000000	1.000000	-5.423060	9.697983
			(4.11318)	(2.55122)

Adjustment coefficients (standard error in parentheses)

D(SR)	-0.046312	0.152319	0.019499
	(0.06078)	(0.13343)	(0.04555)
D(LOILP)	0.052704	-0.131179	-0.000314
	(0.02162)	(0.04747)	(0.01621)
D(EXR)	-0.445089	0.687521	-0.189736
	(0.10504)	(0.23058)	(0.07872)
D(LM3)	-0.000394	0.006060	0.002248
	(0.00173)	(0.00381)	(0.00130)
D(LGP)	-0.001594	-0.034930	-0.026124
	(0.01090)	(0.02393)	(0.00817)

4 Cointegrating Equation(s): Log likelihood 692.1817

Normalized cointegrating coefficients (standard error in parentheses)

SR	LOILP	EXR	LM3	LGP
1.000000	0.000000	0.000000	0.000000	-1.668989
				(0.51779)
0.000000	1.000000	0.000000	0.000000	-2.154659
				(0.44520)
0.000000	0.000000	1.000000	0.000000	12.47190
				(3.33094)
0.000000	0.000000	0.000000	1.000000	0.511504
				(0.23566)

Adjustment coefficients (standard error in parentheses)

D(SR)	-0.225868	0.230353	0.039220	-0.476126
	(0.08847)	(0.13171)	(0.04448)	(0.60190)
D(LOILP)	0.009439	-0.112376	0.004438	-0.222041
	(0.03213)	(0.04783)	(0.01615)	(0.21859)
D(EXR)	-0.383822	0.660895	-0.196465	3.619079
	(0.15850)	(0.23597)	(0.07969)	(1.07838)
D(LM3)	-0.000285	0.006012	0.002236	-0.027029
	(0.00262)	(0.00390)	(0.00132)	(0.01783)
D(LGP)	-0.008809	-0.031795	-0.025332	0.253846
	(0.01644)	(0.02448)	(0.00827)	(0.11187)

APPENDIX E: PAIRWISE GRANGER CAUSALITY TESTS

Pairwise Granger Causality Tests
Date: 01/28/18 Time: 12:08
Sample: 2007M06 2015M11
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
OILP does not Granger Cause OILGAS	100	2.50099	0.0874
OILGAS does not Granger Cause OILP		3.52685	0.0333
EXR does not Granger Cause OILGAS	100	0.34016	0.7125
OILGAS does not Granger Cause EXR		0.86485	0.4244
M3 does not Granger Cause OILGAS	100	0.08293	0.9205
OILGAS does not Granger Cause M3		0.94608	0.3919
GP does not Granger Cause OILGAS	100	0.79770	0.4534
OILGAS does not Granger Cause GP		0.19299	0.8248
EXR does not Granger Cause OILP	100	5.87604	0.0039
OILP does not Granger Cause EXR		2.55907	0.0827
M3 does not Granger Cause OILP	100	0.01683	0.9833
OILP does not Granger Cause M3		0.51666	0.5982
GP does not Granger Cause OILP	100	1.61484	0.2043
OILP does not Granger Cause GP		0.09098	0.9131
M3 does not Granger Cause EXR	100	0.01114	0.9889
EXR does not Granger Cause M3		1.07291	0.3461
GP does not Granger Cause EXR	100	0.92843	0.3987
EXR does not Granger Cause GP		0.56355	0.5711

GP does not Granger Cause M3	100	0.74492	0.4775
M3 does not Granger Cause GP		0.34745	0.7074

APPENDIX D: VARIANCE DECOMPOSITION

Variance Decomposition of OILGAS: Period	S.E.	OILGAS	OILP	EXR	M3	GP
1	0.242868	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.257660	90.18786	4.492487	1.484889	1.406169	2.428597
3	0.274280	85.55268	5.036931	3.019027	2.581164	3.810202
4	0.301440	81.37781	4.448865	6.480548	3.743989	3.948793
5	0.313836	80.24990	4.965615	6.239922	4.016161	4.528405
6	0.329718	79.54799	5.016450	6.559317	4.298080	4.578163
7	0.346467	78.63026	5.046776	7.038023	4.481039	4.803898
8	0.359667	77.48523	5.286046	7.267241	4.813103	5.148384
9	0.373841	76.78045	5.314713	7.588281	5.042859	5.273700
10	0.387244	76.15645	5.376925	7.825196	5.207713	5.433720

Variance Decomposition of OILP: Period	S.E.	OILGAS	OILP	EXR	M3	GP
1	0.086551	5.744603	94.25540	0.000000	0.000000	0.000000
2	0.110151	10.79809	81.94008	6.274291	0.477047	0.510493
3	0.127129	8.384627	84.88318	5.404657	0.560339	0.767197
4	0.141652	8.502620	85.80529	4.421463	0.456756	0.813870
5	0.154793	7.925203	86.45348	4.214813	0.406456	1.000048
6	0.167025	7.730161	86.72776	4.205421	0.350394	0.986266
7	0.178252	7.664082	87.08891	3.950865	0.307667	0.988474
8	0.189075	7.501701	87.31217	3.876455	0.274850	1.034823
9	0.199136	7.381645	87.56021	3.759235	0.250657	1.048257
10	0.208703	7.301846	87.74641	3.659785	0.228893	1.063069

Variance Decomposition of EXR: Period	S.E.	OILGAS	OILP	EXR	M3	GP
1	0.052688	0.010811	6.655243	93.33395	0.000000	0.000000
2	0.054518	0.201580	10.33176	89.37153	0.063433	0.031698
3	0.058362	1.046506	13.32899	83.70539	0.272888	1.646225
4	0.063226	2.801391	14.56342	79.13735	1.687361	1.810470
5	0.065997	2.862244	15.48700	78.25000	1.676865	1.723896
6	0.069557	3.110567	16.44516	77.01183	1.660244	1.772206
7	0.072931	3.202312	17.18601	76.07268	1.769543	1.769453
8	0.075782	3.429027	17.97790	74.94142	1.847053	1.804596
9	0.078756	3.634857	18.56652	74.03786	1.910357	1.850406
10	0.081548	3.747947	19.04302	73.36901	1.981718	1.858306

Variance Decomposition of M3: Period	S.E.	OILGAS	OILP	EXR	M3	GP
1	0.006327	1.430865	0.655640	8.643817	89.26968	0.000000

2	0.006745	1.377890	0.706561	14.80157	82.99503	0.118945
3	0.007370	1.516766	0.909012	17.96570	78.65887	0.949655
4	0.008375	4.272327	1.120649	22.43541	71.12997	1.041644
5	0.008861	3.822185	1.006672	23.90469	70.23537	1.031081
6	0.009416	3.835589	1.058464	24.81534	69.21361	1.076995
7	0.009971	3.823778	1.089316	25.61626	68.37635	1.094287
8	0.010458	3.620830	1.061440	26.84366	67.34522	1.128852
9	0.010937	3.630502	1.079325	27.46517	66.65076	1.174242
10	0.011396	3.583068	1.075813	28.08131	66.07538	1.184431

Variance Decomposition of GP: Period	S.E.	OILGAS	OILP	EXR	M3	GP
1	0.047159	5.341184	0.852441	1.643659	4.353437	87.80928
2	0.052702	8.693981	0.721659	4.107404	4.723143	81.75381
3	0.057514	9.904404	0.612561	6.908344	4.716981	77.85771
4	0.064788	11.65571	0.567750	9.432324	3.751834	74.59239
5	0.069786	12.85303	0.543582	9.672071	3.817271	73.11404
6	0.074701	13.08973	0.512536	10.28014	3.739183	72.37840
7	0.079223	13.28464	0.493510	10.63367	3.607821	71.98036
8	0.083565	13.89588	0.460613	10.98500	3.525164	71.13334
9	0.087697	14.11169	0.447001	11.36350	3.442066	70.63574
10	0.091614	14.33708	0.434660	11.60915	3.369431	70.24969

Choleky Ordering: OILGAS OILP EXR M3 GP