

**IMPACT OF OIL PRICE SHOCKS ON
MACROECONOMIC VARIABLES IN NIGERIA**

BY

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**BEING A DISSERTATION SUBMITTED TO THE DEPARTMENT OF
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IN ECONOMICS**

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DECLARATION

I, Sumayya Adam Ahmad, declare that this dissertation is my own work and all the sources that I used or quoted have been indicated and acknowledged by means of completed references under the supervision of Dr. Bello Ado. This dissertation has not, either in whole or part, been submitted for a degree or certificate at another university.

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CERTIFICATION

I, Sumayya Adam Ahmad certify that this dissertation work was conducted, written and compiled by me, I also certify that to the best of my knowledge this work has never been presented wholly or partially for the award of any degree or for publication elsewhere.

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APPROVAL PAGE

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DEDICATION

This research work is dedicated to my beloved parents; Professor Adam Ahmad and Professor JuwairiyyaBadamasiuy.

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ABSTRACT

The empirical questions of the study are established based on oil price and macroeconomic performance of the Nigeria's economy. Thus, the study aims at exploring the dynamics of oil price volatility with a view to provide the forecast of oil price as well as analysis of reaction of key macroeconomic variables in Nigeria in the wake of oil demand and supply shock. For these objectives to be empirically investigated, two classes of econometric models are used in fitting the data. In one fold, the study opts for markovian regime volatility process model, namely, Markov Switching Generalized Autoregressive Conditional Heteroscedasticity (MS-GARCH) that allows for changes in the conditional volatility. Based on the estimates of the MS-GARCH model, the study provides evidence of changes in the conditional volatility of oil price and shows that volatility of oil price are different in low oil price regime and high oil price regime. In the second fold, the study uses sign-identified Structural Vector Autoregression (S-VAR) to document the different reaction and responses of key macroeconomic variables, specifically, Gross Domestic Product, Exchange Rate and Inflation, to the unexpected shock in the global demand and supply of oil price. Findings from the volatility analysis of oil shows that oil price is characterized with changes in its volatility process and that forecast from MS-GARCH is superior than forecast generated from the traditional GARCH families. Also, findings from sign-identified SVAR shows that previous application of structural models tend to over-estimate the responses of key macroeconomic variables, whereby with oil demand shock, a resultant of global economic activity, Nigeria's real GDP will exhibit positive response, while the exchange rate appreciates immediately then reacts negatively and further plunge into depreciation of the country's currency, and that there are additional sources of macroeconomic fluctuations other than oil price shock. Based on these findings, the study recommends that external absorbers and automatic built-in stabilizers must be put in place to serve as a mechanism for correcting disequilibrium in oil revenue, and external policies needs to be established to thwart the effect of external sector on the currency Forecasting of oil price volatility must consider regimes shift in oil price and policy makers should recognize additional channels of shock transmission other than oil price changes.

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Background to the Study

Crude oil is the most important commodity around the world today, and also the largest resource for man's demand for energy. In modern history, it is the major energy source world-wide due to its high energy density, relatively easy extraction, transportation, and refining.

In this globalized world, all economies are connected either directly or indirectly through international trade (imports and exports of commodities). This activity has influenced many countries both positively and negatively, depending on which side of the coin they are placed. Crude oil as an international trade commodity penetrates economies with its pros and cons whereby its fluctuations and instability have dwarfed and hindered the growth of the macroeconomies indulged in its trade e.g. Nigeria. This is the reason why Nigeria has been referred to as a small open economy by the Global Vulnerability Index.

The discovery of Oil in Nigeria was made in the year 1956 by Shell-BP (Shell-British Petroleum) which was at the time the sole Concessionaire, at Oloibiri in the Niger Delta after a half century of exploration. Nigeria joined the ranks of oil producers in 1958 when its first oil field came on stream producing 5,100 barrels per day. After 1960, exploration rights in onshore and offshore areas adjoining the Niger Delta were extended to other foreign companies (Odularo, 2007). In 1974, Crude oil gradually became the main generator of Nigeria's Gross Domestic Product (GDP), therefore, any shock (positive or negative) in oil results into a tremendous effect in the Nigerian macro-variables, vis-à-vis the macroeconomy in entirety, favorably or adversely.

Crude oil has metaphorically been referred to as the 'black gold'. This is most true and applicable in the Nigerian economy given its sole dependence on it. The impact of crude oil (and its price shocks) in Nigeria has been double-edged; it has benefited the country in some

ways, and detrimental in many other ways. Windfalls that resulted from volatile oil price surges/shocks overwhelmingly flow through the economy; expand the oil sector and penalize the non-oil sector. (Alley et al, 2014). Also, the revenue from oil is the pivot for government budgets and subsidization of domestic petroleum product prices. Hence, oil price changes significantly influence the welfare program of the state. The dependence of the Nigerian economy on oil proceeds as the major source of revenue is capable of raising suspicion about the impact of oil price volatility on macroeconomic volatility in the country.

During the Biafran civil war of 1970, there was a hike in oil price across the world, which had a persuasive effect on the growth & development of the Nigerian economy. Nigeria was able to reap instant riches from its oil production. Consequently, the country suddenly became heavily dependent on crude oil as the major source of revenue, energy and foreign exchange for the entire economy. This substantially affected the scope and content of investment, production and consumption patterns as well as government's policies and programs. It also led to the neglect of the strong agricultural and manufacturing bases of the country. In fact, annual budgets were and still are often formulated in Nigeria based on oil prices. The 2009 budget was revised in line with the prevailing market price of oil indicative of huge dependence of Nigeria on oil proceeds.

According to Galadanchi (2010), Nigeria's crude oil production output rose to an all-time peak producing about 2.44 million barrels per day in 1979. wherein Nigeria's premium crude, the Bonny Light (37 API) fetched the commanding price of 40 dollars a barrel. Nigeria's oil statistics showed that the country had an estimated 36.2 billion barrels of oil reserves which placed the country as the second largest in terms of oil reserve on the African continent. The Energy Information Administration (2009) estimated Nigeria's effective oil production capacity to be around 2.7 million barrels per day. This is the reason why the 2009 budget was revised in line with the prevailing market price of oil indicative of huge dependence of

Nigeria on oil proceeds. In fact, annual budgets were and still are often formulated in Nigeria based on oil prices. When the government is faced with abrupt fluctuations in oil prices, her budget becomes complicated and often imprecise. Hence, the dependence of the Nigerian economy on crude oil cannot be over emphasized.

This high level of dependency on crude oil and neglect of other sectors has resulted in what is known as the Dutch Disease Syndrome; the structural economic imbalance resulting from mismanagement of oil revenue which results in negative impacts on the economy and causing the country's other product to command less price in the competitive market (Broni-Bediako et al, 2018).

According to Chuku (2012), "Oil Price Shocks are unexpected and unpredictable changes in global oil prices, caused by exogenous factors, which are likely to impact on endogenously determined economic variables". Oil price shocks in Nigeria are predominantly defined with respect to price fluctuations resulting from changes in either the demand or supply side of the international oil market (Hamilton, 1983; Wakeford, 2006). It is the tendency of macroeconomic variables such as Gross Domestic Product (GDP), inflation, exchange rate, interest rate etc. to be unstable and weak in terms of withstanding shock. It is a situation whereby little shock in the economy subjects the macroeconomic variables to fluctuations and uncertainty.

The World Bank (2015) raised four causes of sharp oil price drop: a trend of greater-than-anticipated supply and less-than-anticipated demand, changes in OPEC objectives, fading geopolitical concerns about supply disruptions, and US dollar appreciation. In the same vein, Ebrahim et al (2014) recognized three main drivers of oil price volatility: characteristics of oil market fundamentals, speculation in the oil derivatives market, and inadequacies in oil market data. Price volatility in the crude oil market is increasing at a faster rate than volatility in other commodity markets, partly due to the status of oil as the most globalized commodity.

OPEC has played a significant role in oil pricing, therefore the market was affected purely by supply factors. This up until the mid-1990s. However, since then, Alekhina& Yoshino (2018) posited that the power has moved to non-OPEC oil suppliers and notably oil-consumers. This mostly happened because of the rapid economic growth in Asia, especially in India and the People's Republic of China (PRC), which is associated with an increase in energy consumption, especially oil. Increased demand caused diversification of the supply side, and from the late-1990s OPEC was no longer the main oil exporter.

The volatility and uncertainty that now plague oil earnings have resulted in unpredictable investment climate in the country. This uncertainty has even affected the risk that investors face in non-oil activities. World Bank report has also confirmed that oil price shocks are one of the main factors limiting private investment in developing economies. With high oil prices and high revenues, project selection criteria became very lax. Belief in the oil boom encouraged Nigeria to finance large public expenditure programs. But the qualities of most of the investments were so poor that many investments did not pay for themselves. Some projects that might have become viable had oil prices remained high turned non-viable when oil prices fell (Ademakinwa&Omokanbi, 2017). The oil price volatility crisis observed in Nigeria had connections with some movements in key macroeconomic variables in Nigeria.

In 1973, the world experienced an oil price volatility effect that rippled through Nigeria until the mid-1980s. This was initially positive for the country, but with mismanagement and military rule embezzlement, it became all economic disaster. During the first oil shock in Nigeria (1973-74), the value of Nigeria's export measured in US dollars rose by about 600 per cent with the terms of trade rising from 18.9 in 1972 to 65.3 by 1974. Government revenue which stood at 8 per cent of GDP in 1972 rose to about 20 per cent in 1975. This resulted in increased government expenditure owing largely from the need to monetize the

crude oil receipts. Investment was largely in favour of education, public health, transport, and import substituting industries (Nnanna and Masha, 2003).

Lately in the year 2014, starting from mid-2014 to be more precise, there was a sharp decrease in global oil prices, which decreased global crude oil prices to less than half drew attention to the role of oil prices on the macroeconomy and the causes of oil price fluctuation. Oil prices dropped from above \$100 per barrel in June 2014 to less than \$30 per barrel in February 2016. Since early April 2016, oil prices have started to increase again because of a fragile increase in demand, but prices are almost half those in 2014. The expectations, supply, and demand in the oil market are among the several reasons for this sharp drop (Taghizadeh-Hesary et al, 2017). When oil prices had plummeted in mid-2014, Gulf Cooperation Council (GCC) stock indices had all been declining. The GCC countries were not alone in bearing the ill effects of the falling oil prices. The Russian economy for example, had registered a large decline with a 30% drop in its stock market in just the first half of December 2014 (Trabelsi, 2017). Several other countries, including Russia, Nigeria, and Venezuela, also faced similar economic pressures.

It is empirically established that oil price is one of the most volatile prices which has significant impact on macroeconomic behavior of many developed and developing economies. (Abdulkareem and Kilishi, 2016). Hamilton (1983) showed that all U.S. recessions except one since World War II were preceded by a spike in oil prices. Hamilton (1983) was one of the first scholars, who showed the importance of the energy price changes to the U.S. economy when he concluded that oil price increases had contributed to some of the U.S. recessions during the period 1948-1972. The interest in oil price fluctuations and their role in the macro-economy was renewed again due to a sharp increase in oil price in early 2000 and immediate drop in 2008 caused by the Lehman crisis. The second oil shock of

1979 caused by the cut in oil supply highlighted once again the significance of immediate energy price change.

Ben et al (2016) revealed that a little shock in the price of crude oil in the global oil market in the current period will produce a long-term effect on macroeconomic activities in Nigeria. The impact of crude oil (and its price volatility) in Nigeria has been double-edged; it has benefited the country in some ways, and detrimental in many other ways. Windfalls that resulted from volatile oil price surges/shocks overwhelmingly flow through the economy; expand the oil sector and penalize the non-oil sector. (Alley et al, 2014). Also, the revenue from oil is the pivot for government budgets and subsidization of domestic petroleum product prices. Hence, oil price changes significantly influence the welfare program of the state. According to Ogundipe et al (2014), Oil price fluctuations have received important considerations for their presumed role on macroeconomic variables. Higher oil prices may reduce economic growth, generate stock exchange panics and produce inflation which eventually leads to monetary and financial instability. It will also lead to high interest rates and even a plunge into recession (Mckillop, 2004).

By and large, the more a country engages in oil trade, the more it is open to the elements of price shocks on global commodity markets (Rentschler, 2013)

1.2 Statement of the Problem

Crude oil has metaphorically been referred to as the 'black gold'. Generally, oil price fluctuations significantly affect oil importers' production costs and, therefore, price levels, while in energy exporting countries oil price movements mainly affect energy export revenues and government budget revenues. Nevertheless, it was widely accepted that energy price volatility is not only an important cause of macro-economic fluctuations, but also affects the fiscal and monetary policy of different economies (Yoshino and Alekhina, 2016).

There arises a risk of oil price shocks for those energy exporting countries like Nigeria where oil accounts for a significant share of total export and crucially contributes to the government budget. The oil market is highly volatile compared to other commodities due to the fact that oil supply and demand has a low-price elasticity, which makes the price of oil fluctuate widely. It therefore has a direct impact on the oil exporters' economies, as these depend on oil export revenues. The uncertainty advanced by Oil Price Volatility has damaging and destabilizing macroeconomic effects. The high degree of Oil Price Volatility which has characterized the market for the past four decades represents a fundamental barrier to stability and hence growth. The management and reduction of price volatility will play a key role in enhancing stability in future economic growth trajectories (Ebrahim et al., 2014).

A decline in oil prices results in a fall in foreign exchange earnings leading to a fall in the supply of foreign exchange. The resultant excess demand in the foreign exchange market would put pressure on the exchange rate leading to the depreciation of the domestic currency. The interaction of the demand and supply of goods and services across international borders has implication for the exchange rate. Therefore, for a country to appreciate her currency, there is need to stimulate local production with the aim of exporting as well as to reduce the volume of imports (Ogiriki&Werigbelegha, 2017). In oil exporting countries, rising oil prices appreciates exchange rates and falling oil prices depreciates exchange rates, while the opposite is expected to be the case in oil importing countries (Krugman, 1983). There are various evidences, particularly over the post-Breton woods era, pointing to the vital role of oil price fluctuations in the determination of the path of the exchange rate (Adeniyi et al., 2012)

Oil price changes also affect trade. When oil prices increase, the inelastic demand curve for oil means total spending on oil imports increases. This puts pressure on the exchange rate and depreciate the local currency. This reduction in the value of currency may further reduce economic performance (Eagle, 2017). The level at which oil price changes endanger

macroeconomic performance continue to attract theoretical and empirical discussions especially in developing nations. In recent time, the debate has been given impetus in African countries.

Basically, the crux of the problem lies in the fact that the country has extremely relied on this commodity over the years, making its economy a mono-product economy and this has triggered severe structural difficulties for the economy. For example, in 2008 when oil price fell from a peak of \$147 to about \$37.81 per barrel, the budget witnessed significant cuts in budgeted revenue and expenditure. These cuts had attendant effect on all aspects of the Nigerian economy; apparently budgetary operations in Nigeria are strongly linked to happenings (price, demand and supply) in the international oil market. The dominance of oil in the Nigeria's external sector and as its major source of revenue is not in dispute as expounded so far. Recently, the Nigerian economy is hit with global crash in oil prices which subsequently led the economy into its current recession. Following oil price crisis, the exchange rate performance of the country worsens. The cumulative effect of oil price and exchange rate crises expose the role of foreign international variables in shaping the performance of the economy.

The wave of oil price shocks has taken a toll on the economic standing of the nation. The plunge in the price of oil and its volatile behavior currently has resulted in the depletion of our foreign reserves, devaluation of naira amongst others. For example, the crash in the Naira exchange rate from N199=\$1 in Dec. 2015 to almost N500=\$1, by January 2016, was popularly attributed to the erosion of Nigeria's foreign reserves from a relatively lofty perch around \$60bn to a less exotic retreat of about \$35bn, which was caused by the rising oil prices. Although the Naira rate has since stabilised between N305-360=\$1, conversely however, unexpectedly higher (and still rising) oil prices have reportedly since buoyed reserves nearer \$47.62bn by September 2018 (Boyo, 2018). With these therefore, it cannot be

overemphasized, the need to critically investigate the extent to which oil price shocks and volatilities actually affect the Nigerian Macroeconomy.

1.3 Research Questions

With crude oil as the mainstay of Nigeria, the economy is vulnerable to oil price shocks consequences. This raises the following questions;

- i How volatile are crude oil prices in periods of global oil shocks?
- ii What is the performance of volatility models in forecasting of oil price in Nigeria?
- iii What are the channels through which the impact of oil price shocks is transmitted into the macroeconomic variables in Nigeria?
- iv What is the impact of Niger-Delta militant activities on oil production?

1.4 Objectives of the Study

The main objective of this study is to investigate the impacts of crude oil price shocks on the macroeconomic performance of the Nigerian economy. The specific objectives are as follows;

- i To investigate the volatility of crude oil prices in the periods of global shocks.
- ii To provide in-sample and out-sample forecast oil price from volatility models
- iii To identify the transmission channels through which the impact of oil price shocks propagates into the macroeconomic variables in Nigeria.
- iv To assess the impact of Niger-Delta militant activities on oil production

1.5 Scope and Limitations of the Study

The study covers the period from 1980Q₁ to 2017Q₃ in an attempt to examine the impacts of oil price shocks on some relevant macroeconomic variables in Nigeria including Gross Domestic Product (GDP), Exchange rate and Inflation. This period was selected because major oil price fluctuations (both domestic and international incidences) that have extremely affected the Nigerian economy occurred during the time frame. For example; the 1986 oil

market collapse, the 1999, the 2003-2006 oil price fluctuations. And more recently, the 2008 and 2014 crisis which lead to the beginning of recession period in Nigeria in 2016.

The apparent limitation of the study is the unavailability of the desired higher frequency data such as monthly or weekly data, that will be more appealing and behaving for such intensive analysis.

1.6 Significance of the Study

A plethora of empirical evidences in Nigeria over the last few decades, document reasonably sufficient literature on oil price crisis and its macroeconomic effects. Also, there has evidently been an increasing trend of crude oil prices and a close consideration to the demand-side and supply-side effects that sparked these price changes. There is high probability that this trend would keep up in the outlook period and beyond, which will keep on affecting the economy as a whole. This study therefore would contribute immensely to knowledge and understanding of the workings of the economy in Nigeria, as it relates to Crude oil. The result obtained from this work will be useful to the government and also to oil-related organisation like the OPEC, to give the appropriate policy responses to mitigate the effects of Oil price fluctuations when they occur. The research is also an addition to the existing literature in the area.

1.7 Organization of the Study

This work is divided into five chapters:

Chapter One is the Introduction, which comprises of the background of the study, statement of the research problem, research questions, objectives of the study, research hypotheses, scope of the study, and the organization of the study.

Chapter Two entails the conceptual framework, the literature review and the theoretical framework.

Chapter Three broadly focuses on the research methodology.

Chapter Four consists of the analyses, presentations, interpretations and discussions of the data.

Chapter Five is on the summary of the findings, conclusion, and recommendations.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

Overtime, researchers have been concerned with the relationship between oil prices and economic performance, this could be dated back to the great depression of 1980's. Given the effects observed, many puzzling questions have been raised concerning this relationship, hence, numerous studies have been conducted to answer these incessant questions empirically. Although, different outcomes are being realized by different scholars and researchers, whereby various objectives are being achieved by employing various modelling techniques.

Such studies have crossed across borders (both domestic and international) thereby utilizing the models deemed appropriate. On the whole, empirical studies' findings and techniques are varying and conflicting. This presence of contradictory evidence and the complexity of the relationship between oil price shocks and macroeconomic activities indicate the need for re-examination of long run and short run linkages, as this can have serious implications for the pace of development in economies.

This chapter will therefore, be reviewing and discussing vital and relevant literature written by various scholars across the globe on the topic generally and specifically on the research questions contained herein, i.e. the relationship between oil price volatility and some macroeconomic variables. A solid conceptualization of the research will be displayed whereby concepts related to the objectives of this study will be defined and duly explained. Also, the theories in which this research work is based upon will be explained vis a vis relating it to the study.

2.2 Conceptual Framework

2.2.1 World Oil Market

Crude oil is one of the most economically mature commodity markets in the world. Even though most crude oil is produced by a relatively small number of companies, and often in remote locations that are very far from the point of consumption, trade in crude oil is robust and global in nature. The global oil market is the most important of the world energy markets because of oil's dominant role as energy source. The world oil market is complex.

According to U.S. Energy Information Administration (2014), Governments as well as private companies play roles in moving oil from producers to consumers. Government-owned national oil companies (NOCs) control most of the world's proved oil reserves (78% in 2012) and oil production (58% in 2012). International oil companies (IOCs), which are often stockholder-owned corporations, make up the balance of global oil reserves and production. Worldwide proved oil reserves are about 1.6trillion barrels and global oil production averages roughly 90 million barrels a day. There are three types of companies that supply crude oil to the global market.

- ***International oil companies (IOCs):*** These companies are entirely investor-owned and primarily seek to increase their shareholder value. Consequently, they tend to make investment decisions based on economic factors. These companies typically move quickly to develop and produce the oil resources available to them and sell their output in the global market. Although these producers are affected by the laws of the countries in which they produce oil, all decisions are ultimately made in the interest of the company and its shareholders, not a government. These include companies like ExxonMobil, BP, and Royal Dutch Shell.
- ***National oil companies (NOCs):*** These companies operate as an extension of a government or a government agency; by supporting their governments' programs

financially and even strategically. They often provide fuels to their domestic consumers at a lower price than they would provide fuels to the international market. These companies do not always have the incentive, means, or intention to develop their reserves at the same pace as international oil companies. Due to the diverse objectives of their countries' governments, these NOCs pursue goals that are not necessarily market-oriented, including employing citizens, furthering a government's domestic or foreign policies, generating long-term revenue to pay for government programs, and supplying inexpensive domestic energy. Examples of NOCs include Saudi Aramco (Saudi Arabia), Pemex (Mexico), and the China National Petroleum Corporation (CNPC). In 2012, 100 companies produced 84% of the world's oil. NOCs accounted for 58% of global oil production.

- ***NOCs with strategic and operational autonomy:*** These NOCs function as corporate entities and do not operate as an extension of the government of their country. These companies often balance profit-oriented concerns and the objectives of their country with the development of their corporate strategy. This category includes Petrobras (Brazil) and Statoil (Norway).

2.2.2 Crude Oil Price Shock

There is a broad literature on the topic of oil price shocks. Kilian (2009) provides a thorough discussion of the different categories of shocks, noting that the source of the shock is critical in determining its effect on macroeconomic aggregates. Others have focused on the responses in output to oil price movements. Perhaps the most commonly used definition of an oil price shock is a concept that Hamilton (2003) labeled the net oil price increase (NOPI). Underlying this definition are two hypotheses: First, that price movements are not considered shocks unless they pass a relative threshold, and Second, that only positive price movements matter. The relative threshold was meant to eliminate small movements that would not be expected to

trigger an adjustment in production, as well as eliminate any endogenous movements in prices. Hamilton considered only positive price movements to address the observed asymmetry in output responses. This asymmetry, he argues, arises because output “costs” are associated with re-organizing production to economize on higher relative energy costs when energy prices rise above the prior peak but are not subsequently undone when energy prices subsequently fall.

According to Chuku (2012), “Oil Price Shocks are unexpected and unpredictable changes in global oil prices, caused by exogenous factors, which are likely to impact on endogenously determined economic variables”. Oil price shocks in Nigeria are predominantly defined with respect to price fluctuations resulting from changes in either the demand or supply side of the international oil market (Hamilton, 1983; Wakeford, 2006). These changes have been traditionally traced to supply side disruptions such as OPEC supply quotas, political upheavals in the oil-rich Middle East and activities of militant groups in the Niger Delta region of Nigeria. The shocks could be positive (a rise) or negative (a fall). Two issues were identified regarding the shocks; first is the magnitude of the price increase which can be quantified in absolute terms or as percentage changes, second is the timing of the shock, that is, the speed and persistence of the price increase.

Narrowing it down to Nigeria, a major factor that triggered volatile changes in the economy between the third quarter of 2015 and the first quarter of 2017 which led to the economy’s recession was declining global oil price and the slow response of the government in addressing the issues. On the 20th of January 2016, global oil price reached its lowest price of US\$22.48 per barrel (OPEC Reference Basket). It is noteworthy that this is the lowest recorded in over 10 years.

The figure 1 below displays Bonny Light Oil prices and its quarterly movements from 2007Q₁ to 2017Q₂, showing all the global fluctuations experienced during the period.

Apparent is the global oil price sharp positive movement of March 2008 standing at US\$138.74 per barrel, which eventually declined to an all-time low of US\$28 per barrel in January 2016, in between are other changes. As at April 2017, Nigeria’s Bonny light oil price had risen to US\$54.11 per barrel, and at July it is trading at US\$48.3 per barrel (Lagos Business School Report, 2017). These fluctuations have implication in the performance of the Nigerian economy as a whole, hence, there is need to carry out investigations of the impacts, causes, channels of transmission and even forecast future behavior of the oil market prices vis a vis its effect on economic growth.

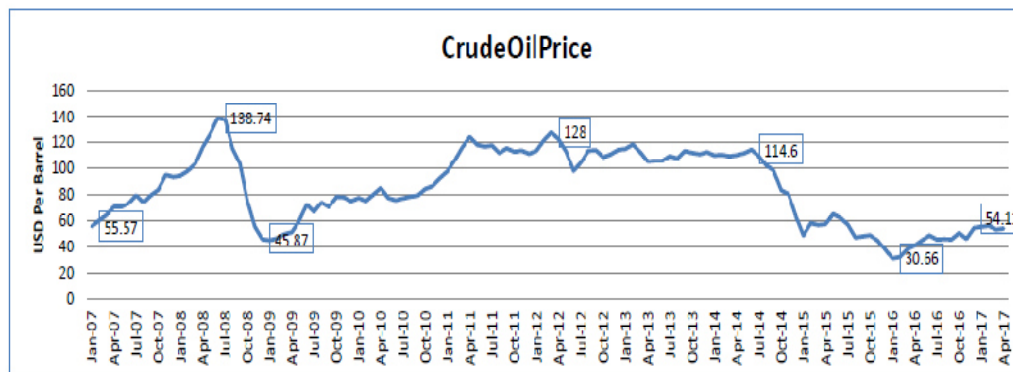


Fig 2.1: Current Trend in Global Oil Prices

Source: LBS Mid-Year Economic Review (2017)

2.2.3 Gross Domestic Product (GDP)

According to Trading Economics (2017), the gross domestic product (GDP) measures national income and output for a given country's economy. The gross domestic product (GDP) is equal to the total expenditures for all final goods and services produced within the country in a stipulated period of time. It is calculated by adding up the value-added at each stage of production (deducting the cost of produced inputs and materials purchased from an industry’s suppliers), and excluding the value of unpaid work (such as caring reproductive labour performed in the home). Gross domestic product (GDP) is arguably the most important aggregate or summary indicator for the purposes of economic analysis and comparisons over time. It measures total domestic economic activity and can be estimated in

three different ways: the production approach; the expenditure approach and the income approach.

Back then, the GDP estimates were used to show that the economy could provide sufficient supplies for fighting World War II while maintaining adequate production of consumer goods and services (Marcuss and Kane, 2007). Economic growth is generally measured in terms of an increase in a nation's Gross Domestic Product (GDP) of goods and services. This can be achieved either by adding raw material inputs and workers, machines etc. or by improving the way inputs and other resources are used.

Marcuss and Kane (2007) asserted that GDP is based on estimates and survey data maintained in a country's System of National Accounts (SNA). These consist of detailed economic census data collected at regular intervals. Annual and quarterly GDP estimates are extrapolated from the census data combined with annual economic survey data such as retail sales, housing starts, and manufacturer shipments. The US Bureau of Economic Analysis' description of GDP states the purpose of measuring GDP is to answer questions such as "how fast is the economy growing?" "what is the pattern of spending on goods and services?" "what percent of the increase in production is due to inflation," and "how much of the income produced is being used for consumption as opposed to investment or savings" (McCulla and Smith, 2007). One thing that wants to be known about an economy is whether its total output of goods and services is growing or shrinking.

GDP is collected at current or nominal prices, which cannot compare two periods without making adjustments to Inflation. *Real GDP* is the value of all final goods and services produced within a country's borders minus the effects of Inflation. To determine this, its nominal value must be adjusted to take into account price changes to allow us to see the reason why the value of output has gone up; is it because more is being produced or is it simply because prices have increased? The growth rate of real GDP is often used as an

indicator of the general health of the economy. That is, an increase in real GDP of an economy shows that the economy is doing well.



Fig 2.2: Nigeria's GDP
 Source: www.tradingeconomics.com|World Bank

As shown in figure 2 above, the Gross Domestic Product (GDP) in Nigeria was worth 405.10 billion US dollars in 2016. The GDP value of Nigeria represents 0.65 percent of the world economy. GDP in Nigeria averaged 92.65 USD Billion from 1960 until 2016, reaching an all-time high of 568.50 USD Billion in 2014 and a record low of 4.20 USD Billion in 1960. Nigeria currently occupies the 26th position in terms of world output. Nigerian economy is currently the largest economy in Africa with a Gross Domestic Product (GDP) of \$415 Billion and a percapitaGDP of \$2,260.3 (World Bank, 2016).

2.2.4 Exchange Rate

Lawrence & Frieden (2006) define the exchange rate as the most important price in any economy, for it affects all other prices. It is the price of one currency in terms of another. It can be expressed in one of two ways, as units of domestic currency per unit of foreign currency or units of foreign currency per unit of domestic currency. The exchange rate is subjected to variations when it is not fixed, thus floating exchange rate tends to be more volatile. Economic essentials affect the level of volatility and the extent to which exchange rate stability is maintained. Favorable economic circumstances and outcome which in turn

would appreciate the currency and maintain stability is caused by strong fundamentals (Mordi, 2006). *Exchange rate volatility* refers to the swings of fluctuations in the exchange rates over a period of time or the deviations from a benchmark or equilibrium exchange rate. It is well-known in literature that getting the exchange rate right or maintaining relative stability is important for both internal and external balance and consequently growth in the economy. Exchange rate is the most important price variable in an economy and performs the twin role of maintaining international competitiveness and serving as nominal anchor to domestic price (Mordi, 2006).

In most countries, policy toward the national currency is prominent and controversial. Economic epochs are often characterized by the prevailing exchange rate system—the Gold Standard Era, the Bretton Woods Era. Contemporary developments, from the creation of an Economic and Monetary Union in Europe to successive waves of currency crises, reinforce the centrality of exchange rates to economic trends. Dury&Oomen (2007) asserted that the real exchange rate is defined as the ratio of the two countries' price indices, expressed in a common currency. But in a world where goods become obsolete and are replaced due to quality improvements, the relevant real exchange rate is the real exchange rate measured in terms of quality-adjusted prices. Here, we examine the impact of quality improvements on two measures of the real exchange rate: the *quality-adjusted* and the *quality-unadjusted* measure. The former measure is calculated using price indices that aggregate prices per quality unit, and hence, by construction, it fully accounts for product quality. The latter measure, on the contrary, is calculated using price indices that aggregate unit prices only, and hence by construction, it fails to account for product quality.

More specifically in Nigeria, Oil price commenced a free fall between 2015 and 2016, as a result, the Naira depreciated at the interbank and the BDC segment of the market. CBN in a bid to check the volatility in the foreign exchange market announced a set of new policy

actions in February 2017. Under this new policy the CBN will provide foreign exchange directly for personal and business travel, medical bills and school fees at a rate not exceeding 20% above the interbank market rate. The effects of the new CBN’s policy on the foreign exchange market was immediate; the Naira appreciated from N520/\$ in February to N390/\$ in April and further to N384.5/\$ in May 2017, at the BDC segment, as shown in figure 3 below. Buoyed by the success, CBN on the 21st of April announced a special window for Investors, Exporters and End-Users, with the aim of boosting liquidity in the forex market. (Lagos Business School Review, 2017).

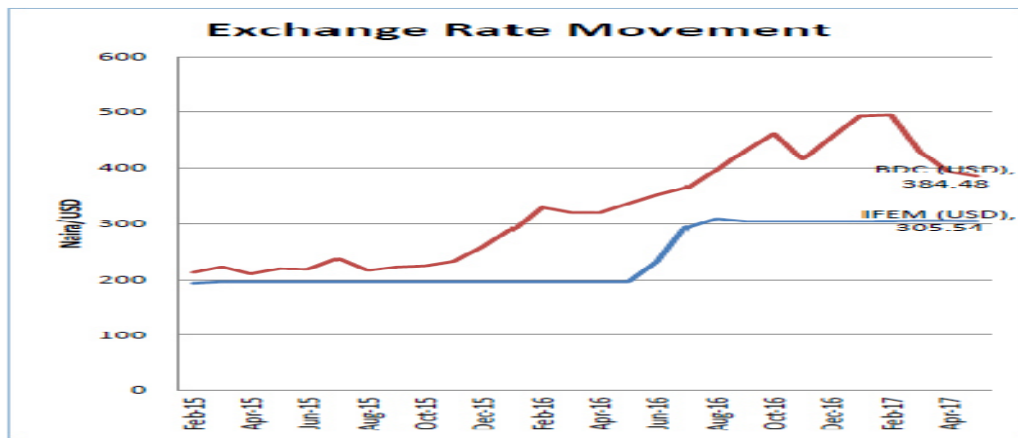


Fig 2.3: Exchange Rate Movement of Naira/USD
Source: Lagos Business School Review, 2017

The volatility of the Naira is reflected more against the dollar and the pounds when one tracks the changes from 1960. Between 1986 and 2016 the naira lost over 89.60% of its value at the official window. Oil is estimated to account for 96% of Nigeria’s export revenue, therefore affecting the exchange rate. In 2016, there was a significant pressure in the currency placed by low oil prices experienced in that period, which till date is yet is still high but steady as depicted in the figure 4 below. This also re-emphasizes the link between oil price changes and the exchange rate of the currency, as they go hand-in-hand in the Nigerian economy.

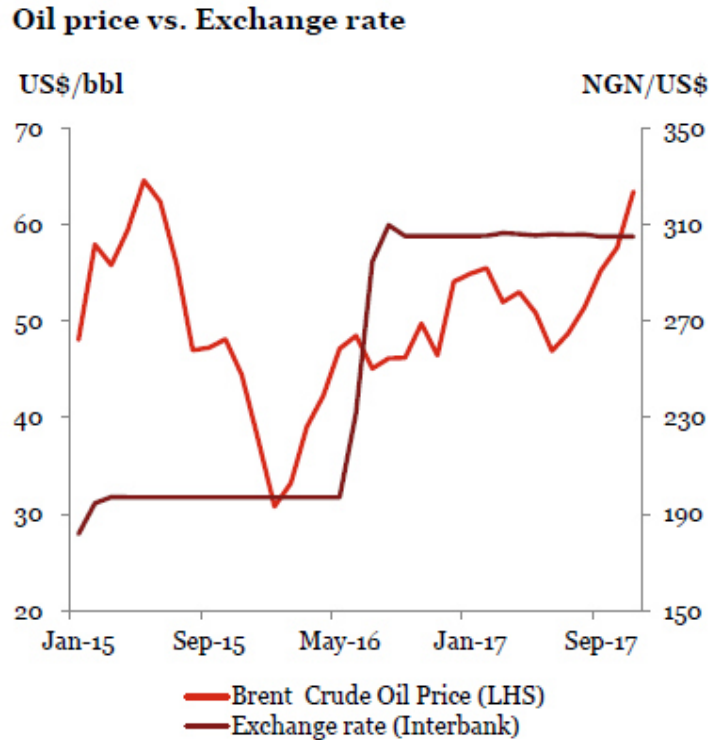


Fig 2.4: The Co-movement of Oil Prices and Exchange rate from 2015 to 2017
Source: Nigeria's Operating Landscape| 2018 PwC analysis

2.2.5 Inflation Rate

Jhingan (2002) defined Inflation as a persistent and appreciable rise in the general level of prices. Not every rise in the price level is termed Inflation. Therefore, for a rise in the general price level to be considered Inflation, such a rise must be constant, enduring and sustained. More explicitly, Inflation is referred to the continuing rise in prices as measured by an index such as the Consumer Price Index (CPI) or by the implicit price deflator for Gross National Product (Jhingan, 2002). In the inflationary process, money loses its value, as inflation is characterized by a fall in the value of the country's currency and a rise in her exchange rate with other nation's currencies. The underlying cause of Inflation is usually that too much money is available to purchase too few goods and services, or when demand in the economy is outpacing supply. This situation normally occurs when an economy is so buoyant that there are widespread shortages of labor and other production inputs, Sellers are then able to charge

higher prices for the same goods or services. Inflation can also be caused by a rise in the prices of imported commodities, such as Oil. When inflation comes to monetary policy formulation, some central banks, like the Federal Reserve in the United States, focus on core inflation, or the underlying trend of consumer prices that excludes certain components in the CPI basket. Most attempts to define core inflation and develop alternative measures have only occurred in the last two decades.

Quah & Vahey (1995) defined core inflation "...as that component of measured inflation that has no medium- to long-term impact on real output". Eckstein (1981) also observed that this notion of core inflation originates in the long-term expectations of inflation in the minds of households and businesses, in the contractual arrangements which sustain the wage-price momentum, and in the tax system. Bryan & Cecchetti (1994) and Wynne (1997) argue that core inflation should just capture the component of price changes that is common to all items and exclude changes in the relative prices of goods and services. Motley (1997) argues that although prices of food and energy have substantial effects on the overall index, they are often quickly reversed and hence do not require a monetary policy response.

The Inflation rate is a measure typically calculated on a month-to-month and year-to-year basis and expressed as percentage. The two main price indexes that measure inflation are The Consumer Price Index (CPI) and The Producer Price Index (PPI);

- **Consumer Price Index (CPI):** a comprehensive measure used for estimation of price changes in a basket of goods and services representative of consumption expenditure in an economy. It is a measure of changes in consumer goods such as food, gasoline, clothing, automobiles etc. The CPI measures price change from the perspective of the purchaser. It is believed to be the most widely used measure of inflation rate.
- **Producer Price Index (PPI):** This is formerly known as Wholesale Price Index. It measures the average change in selling prices received by domestic producers of

goods and services over time. The PPI measures price changes from the perspective of the seller. It shows trends within the wholesale markets, manufacturing industries and commodities markets.

Focusing on the Nigerian economy indices, the CBN Report (2017) asserted that there was an upward pressure on the Consumer price level during the first quarter of 2017. The all-items composite Consumer Price Index (CPI), at late March 2017, was 222.7 (November 2009 as the base), representing an increase of 4.3 per cent and 17.2 per cent, above the levels in the fourth quarter of 2016 and the corresponding quarter of 2016, respectively. The dominant source of this upward pressure is the persistent depreciation of the naira foreign exchange rate and the resultant pass-through to general prices.

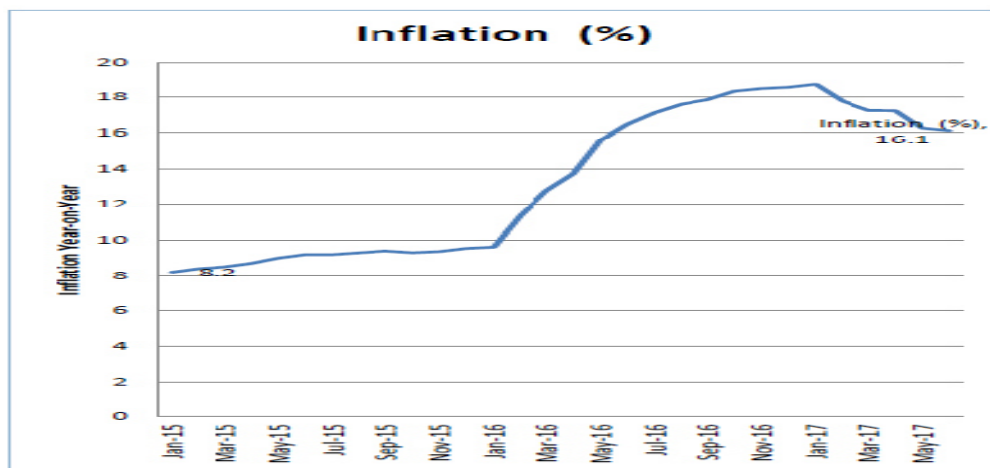


Fig 2.5: Nigerian Inflation Rate Trend (2015 - 2017)
Source: Lagos Business School Report, 2017

According to Lagos Business School Mid-Year Report (2017), Inflation rose from 8.2% in January 2015 to its highest level of 18.72% in January 2017. By February inflation fell to 17.78% and further to 17.24% in April and then 16.1% in the month of June 2017 (figure 5). Falling trend in inflation is a fall out of the continued intervention of the CBN in the FX market. This is reflected in the price of AGO (diesel) which has fallen from a high of from a peak of N260/liter to N150/per liter.

2.3 Review of Theoretical Literature: Theory of Production and Growth

2.3.1 Energy in Production

Reproducibility is a key concept in the economics of production. Some inputs to production are non-reproducible, whereas others can be manufactured at a cost within the economic production system. Capital, Labour, and Land are seen by some Economists as the primary factors of production, and goods such as fuels and materials as the intermediate inputs, which led to an indirect treatment of the role of energy in the growth process. The primary energy inputs are stock resources such as oil deposits. But these are not given an explicit role in the standard growth theories, which focus on labor and capital. However, energy, unlike capital and labour, is a non-reproducible factor of production, although energy vectors are reproducible factors. Therefore, natural scientists and some ecological economists have placed a very heavy emphasis on the role of energy and its availability in the economic production and growth processes.

Biophysical models of the economy propose that energy is the only primary factor of production, which implies that the available energy in each period needs to be exogenously determined. The mainstream neoclassical economists believe that the quantity of energy available to the economy in any period is endogenous, though restricted by biophysical constraints (such as the pressure in oil reservoirs) and economic constraints (such as the amount of installed extraction, refining, and generating capacity), and the possible speeds and efficiencies with which these processes can proceed.

2.3.2 The Mainstream Theory of Growth

This production theory is very general and is less subject to criticism than are the specific models of economic growth. The mainstream economics concept of production function examines the key factors that could reduce or strengthen the linkage between energy and economic activity over time. There is an inbuilt bias in mainstream production and growth

theory to downplay the role of resources in the economy, though there is nothing inherent in economics that restricts the potential role of resources in the economy. The basic model of economic growth is the Nobel prizewinning work by Robert Solow that does not include resources at all. This model subsequently was extended with nonrenewable resources, renewable resources, and some waste assimilation services.

2.3.2.1 The Basic Growth Model

Economic growth models examine the evolution of a hypothetical economy over time as the quantities and/or the qualities of various inputs into the production process and the methods of using those inputs change. In this model based on the work of Solow developed in 1956, a constant-sized labor force using manufactured capital produces output in terms of gross domestic product (GDP). The model assumes that output increases at a decreasing rate as the amount of capital employed rises. This is termed diminishing returns to capital.

In the basic model being examined, technological progress continually shifts the output function upward, and so raises the equilibrium per capita capital stock and output levels. Intuitively, increases in the state of technological knowledge raise the rate of return to capital thereby offsetting the diminishing returns to capital that would otherwise bring growth to a halt.

2.3.2.2 Endogenous Technological Change

The model described above does not explain how technological progress occurs, they are just assumed to happen exogenously, i.e. there is no factor inside the model that brings about the improvement in technology. In endogenous growth models, the relationship between capital and output can be written in the form $Y=AK$. Capital, K , is a composite of manufactured and knowledge-based capital. Endogenous growth theorists have been able to show that, under reasonable assumptions, the A term in the preceding expression is a constant, and so growth can continue indefinitely as capital is accumulated.

Technological process can be seen as a form of capital, which is accumulated through research and development (R&D) and other knowledge-creating processes. Those new knowledge increase the stock of ideas in the economy, and as a result, other factors capital and labour becomes more productive. There are two special properties of technological knowledge, first being a public good and second, being able to generate positive externalities in production. These externalities create momentum in the growth process. As firms install new capital, this tends to be associated with process and product innovations. The incentive to devote resources to innovation comes from the prospect of temporary monopoly profits for successful innovations.

The growth of K thus means the growth of a composite stock of capital and disembodied technological knowledge. Therefore, output is able to rise as a constant proportion (A) of the composite capital stock, and is not subject to the diminishing returns. So, in an endogenous growth model, the economy can sustain a constant growth rate in which the diminishing returns to manufactured capital are exactly offset by the technological growth external effect just described.

2.3.2.3 Growth Models with Natural Resources

The growth models discussed so far do not include Natural resources. Some environmental resources are nonrenewable, and many renewable resources are potentially exhaustible. Some natural resources exist in finite stocks or flows, while some, such as sunlight or deuterium, are available in very large quantities. Finiteness and exhaustibility of resources make the notion of indefinite economic growth problematic. Even maintaining the current level of output indefinitely may be difficult.

Neoclassical economists are primarily interested in what institutional arrangements, and not what technical arrangements, will lead to sustainability. They typically assume a priori that sustainability is technically feasible, and then investigate what institutional arrangements

might lead to sustainability if it is technically feasible. However, there is a tendency among mainstream economists to assume that sustainability is technically feasible unless proved otherwise. Substitution that is technically possible will not occur unless society invests in sufficient capital over time to replace the depleted natural resources and ecosystem services. The other key factor permitting growth in the face of a limited resource base is technological change. A technological improvement is defined as a gain in total factor productivity, which implies that output increases while a weighted sum of the inputs to production is held constant. Thus, growth would be possible when faced with finite resources.

Theoretical Framework:

Numerous ideas and views exist about the linkages between energy and economic growth, among which have been reviewed above. This research finds the theory; “*Growth Models with Natural Resources*” as modified by Stern (2004) quite relevant and most appealing in suiting this research work which prompts the researcher to build the research tenets on it, as the theory is linking economic growth via natural resources endowments. However, there are some adjustments made here. First, the research will narrow the scope of the definition of natural resources to only non-renewable energy production i.e. crude oil production. Second, a modification of using control variables is made in this research. The control variables will indirectly affect economic growth and they include exchange rate and inflation rate. The research therefore, will be examining the shocks propagation from the natural resource (oil) on growth vis-à-vis the control variables.

Mathematically, researchers interested in the effect of natural resources on economic growth estimate a variant of the following model as in Havranek et al (2016):

$$G_{it} = \alpha + \beta NAT_{it} + \gamma NAT_{it} * INS_{it} + \theta X_{it} + \epsilon_{it} \dots \dots \dots (2.1)$$

Where i and t denote country and time subscripts; G represents a measure of economic growth;

NAT represents a measure of natural resource richness; *INS* represents the institutional quality of a country and *NAT*INS* is an interaction term between natural resources and institutional quality; *X* is a vector of control variables, such as macroeconomic conditions; and ϵ denotes an error term.

The above equation apparently describes a general panel data setting which encompasses both cross-sectional and time-series studies. In the same note, by modification to time-series and substituting the variables concerned in this study, we have thus;

$$GDP_t = \alpha + \beta OIL_t + \gamma OIL_t * INS_t + \theta X_t + \epsilon_t \dots \dots \dots (2.2)$$

Where *GDP* and *OIL* represent the growth and natural resources respectively as postulated in the theory. *INS* represents institutional quality; several literature have overtime demonstrated that the quality of domestic institutions is likely to be an important factor influencing the magnitude as well as the direction of the effect of natural resources on economic growth. This may include the market structure, system of property rights and system of values for welfare of future generations. However, $X=EXR+INF$, i.e. *X* is a vector of control variables which are the macroeconomic conditions or characteristics that will affect the impact and propagation of the natural resource on growth, which in this study are the exchange rate and inflation rate. α and ϵ represent the constant and the residual error term respectively.

2.4 Empirical Literature Review

2.4.1 Impact of Oil Price Volatility on Non-Nigerian Macroeconomy

As earlier established the Global Oil price fluctuations have directly or indirectly affected the macroeconomic variables and hence economic growth, of not just Nigerian economy but the economies of other oil-exporting and even oil-importing countries. Studies have been conducted to ascertain the exact impact.

Some studies employed the Vector Auto Regression (VAR) by Sims (1980);

Alekhina and Yoshino (2018) investigated the interrelationship between the main macroeconomic indicators of a non-OPEC oil exporting country and world oil prices using a Vector Autoregressive (VAR) approach. Monthly data set of 288 observations was used, starting from January 1993 to December 2016. The results suggest that oil price fluctuations have a significant impact on the oil exporting country's real GDP, CPI inflation rate, interest rate, and exchange rate. The monetary policy of the economy was also estimated where evidence suggests that the Taylor rule describes the post-financial crisis monetary policy of this economy relatively well.

Besso and Feubi-Pamen (2016) used Panel VAR model approach to evaluate the impact of oil fluctuations on the GDP and investigate the sources of macroeconomic fluctuations in some CEMAC countries (i.e. Cameroon, Chad, Congo Republic, Gabon, and Equatorial Guinea). The paper used annual data from 2000 to 2015 for four macroeconomics variables including real GDP growth, real oil prices, consumer index, and supply money. It was realized that the CEMAC countries greatly depend on oil rent representing 19.6% of the GDP of the zone. Also, the oil price shock contributes more to fluctuations of the Gross Domestic Product than the inflation rate and money supply. Nchor et al. (2016) found that both linear and nonlinear oil price movements have adverse impact on macroeconomic variables in Ghana, using variables; Real oil price, real government expenditure, real industry value added, real imports, inflation and the real effective exchange rate, from 1980 to 2014.

Likewise, Benhabib et al (2014) investigated the relationship between oil price and the nominal US Dollar/Algerian Dinar exchange rate through an empirical analysis upon monthly data for the period 2003-2013. The findings in their research work showed no cointegration relationship between the oil and exchange rate in Algeria, and there is the possibility of the Algerian exchange rate to respond to oil price shocks to be insignificant, reflecting the puzzling role of the exchange rate policy in Algeria.

Among the studies that utilized the Structural Vector Auto Regression (SVAR) approach; Fueki et al (2018) proposed a comprehensive structural vector autoregressive (SVAR) model to examine the underlying factors of oil price dynamics, by uniquely and explicitly assessing the role of expectations on future aggregate demand and oil supply in addition to the traditional realized aggregate demand and supply factors. Monthly data set was utilized from March 2005 to February 2016, for the global oil prices, global real economic activity, GDP, Oil inventory and real oil prices. Their analyses showed that identified future demand and supply shocks explain about 30-35 percent of historical oil price fluctuations. The empirical result indicates that the influence of oil price shocks on global output varies according to the nature of each shock.

Brini et al (2016) also analyzed the impact of oil price fluctuations on Inflation and the real exchange rate in six oil exporters and importers MENA countries namely; Tunisia, Algeria, Bahrain, Morocco, Saudi Arabia and Iran during January 2000 to July 2015 period. The monthly data series include Oil price, World oil production, Inflation and the Real exchange rates. It was revealed that Oil price shock induces appreciation in domestic currency for Algeria and Bahrain in the short-run and fairly stable in the long-run; but reduces the domestic currency in Tunisia and Morocco. However, Iran and Saudi Arabia display similar responses contemporaneously; the real exchange rate remain fairly stable for six months.

Similarly, Ghosh (2016) also investigated the dynamic relationship between movements in oil prices and exchange rates with macroeconomic variables like world oil price, federal fund rate, industrial production, inflation, exchange rate, output, interest rate and money demand. The data are in monthly frequency for the sample period January 2000- December 2013. The results show that the shocks have consequential impact on the Indian economy. Also, a negative innovation in oil price has a favorable long term effect on output, prices go down temporarily and rupee appreciates in the short term. However, Rupee depreciation causes a

medium to long term decline in output, demand for money and world price of oil. It has a small effect on inflation causing it to increase temporarily. It was also found that the economy responds asymmetrically to positive and negative shocks to oil prices.

Using monthly data from 1992:4-2001:10 and 2001:11-2014:5, Kim et al (2014) utilized Time-varying parameter structural vector Autoregression (TVP SVAR) model, Structural VAR (SVAR) model, and Generalized impulse response VAR (GIR VAR), to empirically analyze the effect of oil price fluctuations on China's economy. In the earlier period, the interest rate shows a negative response to the oil shock, which was identified as a precautionary demand shock, hence economic-boosting, while in the latter period, interest rate showed a positive response to the shock, which is identified as a positive world oil demand shock. Dias (2013) also investigated the effect of oil price shocks on GDP, Inflation and employment in the Portuguese economy using Price of Oil, GDP deflator, Consumer price index, Wages, GDP, and employment with data from 1984Q₁ to 2012Q₄. It was found that increase in oil price leads to a depressive effect on the level of GDP in the long run, and somewhat similar but smaller, for level of employment.

Zaytsev (2010) found that abrupt increase in the price of oil has no negative contemporaneous effect on real GDP in Ukraine, and that transmission of oil price increase to real economy occurs mainly through cost and downward demand effects. Asymmetry effect was absent in the data. The data from 01/1996 to 12/2006 of Nominal foreign exchange rate, CPI, real GDP, interest rate, monetary aggregate M1 and average world price of oil, were used.

Small-scale VAR models; Threshold and Regime Switching, have been employed in recent studies;

Hom-Hadulla and Hubrich (2017) employed the Regime-Switching Vector Autoregressive (RS-VAR) model estimated with Bayesian methods that allow time-varying transition probabilities developed in Hubrich, Waggoner and Zha (2016) to investigate the transmission

of oil price shocks, to examine whether the notion of episodic changes in the macroeconomic implications of oil price fluctuations finds empirical support in the euro area context, hence, oil price changes was chosen as the driver of switching between different regimes. The analysis provided evidence of two regimes (“normal” and “adverse”) that are characterized by qualitatively different patterns in economic activity and inflation following oil price shocks. Overall, the dynamics observed in the adverse regime are consistent with the presence of second-round effects of oil price shocks on growth and inflation, with wage-price spirals acting as a key channel for the positive co-movement between these variables.

Also, AbulBasher et al. (2015) investigated the impact of oil volatility on real exchange rates for a sample of oil exporting countries (i.e. Brazil, Canada, Mexico, Norway, Russia and the United Kingdom) and oil importing countries (i.e. India, Japan, South Korea). They employed a two-stage approach; firstly, constructed the demand and supply shocks in the crude oil market using the identification procedure developed by Kilian (2009). Then secondly assess empirically the responses of exchange rates of selected oil-exporting and oil-importing countries to the demand and supply shocks in the crude oil market in a Markov-switching framework. For the study, monthly data on world oil supply, global real economic activity, oil prices, and exchange rates were used. The estimation sample beginning period varies by country but harmoniously end in February 2014. From the linear regression results, oil shocks had a statistically insignificant impact on exchange rates for five of the nine countries studied, indicating that a linear model evidence of oil shocks affecting real exchange rates is limited. However, from the Markov switching modelling results, oil shocks had a statistically significant impact on exchange rates in at least one state for each country providing more substantial evidence of oil shocks affecting real exchange rates.

Few studies employed other models like OLS, like that of Jawad and Niazi (2017) analyzes the effect of oil price volatility on economic growth of Pakistan with the macroeconomic

variables (Trade balance, private sector investment and public sector investment). From the Linear regression model results, oil price volatility and private sector investment have insignificant effect on the Gross domestic production, while Public sector investment and Trade Balance do not.

The studies that utilized the Generalized Autoregression Conditional Heteroskedasticity (GARCH) include Mendoza and Vera (2010) estimated the effects of unexpected changes in oil prices on output for the case of Venezuela, using Real GDP, oil GDP, Nonoil GDP and Oil prices from 1984:1 to 2008:3. They found that Oil shocks have asymmetric effects on output growth, in that, positive oil price shocks have had a greater effect on output than the negative had, and that Oil shocks has a positive and significant effect on the Venezuelan economy.

An example of a study that employed the Simultaneous Equation Model (SEM), is that of Taghizadeh-Hesary et al. (2017) who attempted to investigate how fluctuations in oil price affect the economy of oil-exporting countries (Iran, the Russian Federation), oil-importing countries (Japan, the People's Republic of China [PRC], and the Republic of Korea), and their business partners (16 cases e.g. Netherlands, Italy, Germany, United States, Kazakhstan, Belarus, Turkey, India, Malaysia etc.). to estimate the econometric model, a simultaneous equation model (SEM) was applied through a weighted two-stage least squares estimation method to different countries (21 cases) with business relations, to cover a quarterly sample period from Q1 2000 to Q4 2015. The study uses quarterly data of real GDP in US dollars, real oil price in US dollars, long-term interest rate, real effective exchange rate (REER), and export share in percentages. From their results, it was found that the indirect effect for oil-exporting countries is negative and statistically significant, except in the cases of Kazakhstan and Indonesia; The direct effect of a positive oil price shock on the GDP growth rate of oil-exporting countries is positive; and countries importing oil face a negative supply shock

except Turkey which benefits directly from an oil price shock, while the indirect effect coefficient for all these countries was positive.

By majorly using the Error Correction Model (ECM), Shafi et al (2015) attempted to identify the impact of exchange rate volatility and oil prices fluctuations on economic growth in France based on annual data for forty years (i.e. 1971-2012) of different variables like government investment and consumption decisions, foreign direct investment, industrial and manufacturing growth rate, oil prices and exchange rate. Error Correction Mechanism (ECM) and Engle Granger Cointegration test were employed. From the results, rise in oil prices will be affecting positively to gross domestic product of the France and in exchange rate will cause decrease in gross domestic product and vice versa. Also, Foreign direct investment and import of the country has significant positively related to the exchange rate while the exports and other factors has negatively related to the real effective exchange rate.

In the same vein, Abdullah & Masih (2014) empirically tested for the ‘time-varying’ and ‘scale dependent’ correlations between selected commodities and selected macroeconomic variables taking Malaysia as a case study. The data used in this paper is the monthly data of three commodities (crude oil, gold and corn) prices and Malaysia macroeconomic variables consist of Kuala Lumpur Composite Index (KLCI), industrial production, consumer price index (CPI), middle rate of base lending rate (BLR), 3 months treasury bill discount rate (T-bill) and money supply (M2) from 1 January 1990 until 1 December 2013. This study employs a time series technique namely cointegration, vector error-correction model (VECM), variance decompositions (VDC) and persistence profile (PP) in order to find empirical evidence of the nature of relations between crude oil price and Malaysia macroeconomic variables. Our findings tend to suggest that there is a theoretical relationship between the selected macroeconomic variables and the selected commodities and that the

crude oil, gold, KLCI, CPI, BLR and T-bill are exogenous but the corn, industrial production and M2 are endogenous

Bondzie et al (2014) estimated a Dynamic Stochastic General Equilibrium (DSGE) model to examine the persistent effects of world oil price and monetary policy shocks (money supply-interest rate induced) on economic growth in Ghana. The variables used include Consumption, Investment, Output, Money Supply, Money Growth Rate, Inflation, Real Wage, Nominal Interest Rate, and Capital Service. The benchmark simulation via Dynare captured interest rate shock and this leads to a sharp rise in prices which reflects the impact of the increase in interest rate on the marginal cost. The model also shows that a positive output shock has the same effect on consumption, investment, prices and wages as it occurred when there is an interest rate shock. There is a paradoxical effect of a negative interest rate on total money supply.

2.4.2 Oil Price Shocks Propagation on Macroeconomic Performance of Nigerian Economy

Over the years, studies on the macroeconomic influence of Oil price shocks in Nigeria have been quite numerous, controversial and interesting. Controversial because different revelations and results and have been found, by utilizing different modelling techniques.

Some researchers utilized the Vector Auto Regression (VAR) model framework to study this impact, which include;

Umoru et al (2018) analyzed the influence of oil price volatility on Exchange Rate Variability, External Reserves, Government Expenditure and real Gross Domestic Product using the methodology of Vector Auto-Regressive (VAR) on quarterly time series data from 1981 to 2016 for each variable aforementioned. The results of the research show that unstable oil price exerts varying degrees of deleterious effect on exchange rate variability, external reserves, Government expenditure and real gross domestic product (GDP). also,

unidirectional causality was found from oil price fluctuations to economic growth and vice versa, while there exists bi directional causality from nominal exchange rates to economic growth.

Ogunsola et al. (2017) examined the dynamic relationship that exists among oil price, exchange rate volatility and economic growth in Nigeria. Secondary data were used for variables; real gross domestic product, exchange rate, money supply and inflation rates. Co-integration analysis and Vector Autoregressive model (VAR) were employed as techniques of analysis. The result showed that oil price volatility has negative but insignificant relationship with economic growth as 1 percent increase in oil price volatility reduces real gross domestic product by 1.7 percent. In the same vein, exchange rate volatility has insignificant adverse effect on real GDP as 1 percent increase in exchange rate volatility brings about 2.6 per cent decrease in real GDP. The study concluded that oil price volatility depresses economic growth more than volatility in exchange rate, a scenario that may attribute to mismanagement of oil revenue in the country.

Ben et al (2016) who estimated the relationship between oil price changes, inflation rate, Gross Domestic Product and real exchange rate using annual data from the year 1979 to 2014. It was observed that a proportionate change in oil price leads to a more than proportionate change in real exchange rate, interest rate and Gross Domestic Product in Nigeria. The study further reveals that a little shock in the price of crude oil in the global oil market in the current period will produce a long-term effect on macroeconomic activities in Nigeria. Similarly, Ekong&Ebong (2016) focused on majorly modelling the dynamic relationship that exists between crude oil prices, stock market indicators and the economic growth in Nigeria by estimating a monthly data series containing 239 observations from 1995:1 to 2014:11 for variables including Crude oil prices, Gross domestic product, Market capitalization and Exchange rate. It was evident by inference, there is no instantaneous

causality between the variables, and that Oil price decrease leads to depreciation in exchange rates of naira significantly after a period of two months. Again, Osuji (2015) analyzed the impact of oil price movements on exchange rate and the nature of causal link between them using the OLS and VAR respectively, using 420 observations from monthly time series data for the period January 2008 to December 2014. There was evidence of unidirectional Granger causality from oil prices to exchange rate and from oil prices to foreign reserves. Compared to imports, oil prices significantly affect exchange rate.

In the same vein, Okoro's (2014) study examined oil price volatility and economic growth in Nigeria linking oil price volatility, crude oil prices, oil revenue and Gross Domestic Product, using quarterly data spanning 1980-2010, a non-linear model of oil price volatility and economic growth was estimated using the VAR technique. The study revealed that oil price volatility has significantly influenced the level of economic growth in Nigeria. Although, the result additionally indicated a negative relationship between the oil price volatility and the level of economic growth. Similarly, Akinleye and Ekpo (2013) employed quarterly data for the period 1970:I-2010:IV to examine the effects of oil price shocks and oil revenue shocks on different sectors of the Nigerian economy; the supply-side of the economy, real balances, inflation and the sector adjustment effects. Their findings showed that the positive and negative oil price shocks influence real government expenditure in the long run rather than in the short run. Positive oil price shocks have strong short and long run effects on real GDP, therefore triggering inflationary pressures and domestic currency depreciation as importation rises. On the asymmetric effects of oil revenue shocks revealed that positive shocks to oil revenue stimulate expansionary fiscal posture in the Nigerian economy in the short run, thereby also creating inflationary pressure and domestic currency depreciation.

Oriakhi and Osaze (2013) examined the consequences of oil price volatility on the growth of the Nigerian economy within the period 1970 to 2010. Using quarterly data and employing

the VAR methodology, the study found that of the six variables employed, oil price volatility impacted directly on real government expenditure, real exchange rate and real import, while impacting on real GDP, real money supply and inflation through other variables, notably real government expenditure. This implies that oil price changes determine government expenditure level, which in turn determines the growth of the Nigerian economy. Also, Gunu and Kilishi (2010) examined the impact of oil price fluctuation in the Nigeria economy using some key macroeconomic variables; Real GDP, Crude Oil Price, Money supply, Unemployment and Consumer Price Index between 1970 to 2008. They found that GDP and crude oil prices are positively related, while crude oil prices are inversely related to money supply and unemployment.

Some researchers extended to the Structural form of VAR (SVAR);

Eagle (2017) examined the relationship between oil price volatility and macroeconomic performance in two top net oil exporting countries in Africa (Angola and Nigeria) using quarterly data between 1990 and 2014 for variables including Foreign interest rates, Money supply, Inflation rate, Exchange rates, GDP growth, and Domestic interest rates to carry out the empirical analysis. Using Structural Vector Autoregressive Model (SVAR), E(GARCH) and Granger Causality test results shows that oil price volatility has marginal impact on growth rate of GDP in both countries. Both impulse response function and variance decomposition shows that shocks to exchange rate from oil price volatility was the highest i.e. exchange rate appreciates when oil price increases and depreciates when oil price reduces. The Granger causality test shows that the direction of causality between oil price volatility and macroeconomic variables in Nigeria was bi-directional while the relationship in Angola was unidirectional. Hence, both countries (Angola and Nigeria) should improve upon the refining capacity of their crude oil. Similarly, Ademakinwa&Omokanbi (2017) examined the effects of crude oil price fluctuations on foreign direct investment (FDI) and economic

growth. the study used time series data of six variables; oil price (OILP), foreign direct investment (FDI), exchange rate (EXR), trade-openness (TRAOP), inflation (INF) and gross domestic product (GDP) for period 1980 to 2014. The study found out that the oil price shocks have a great influence on the level of domestic and foreign direct investment which greatly influenced the level of growth in the Nigerian economy. However, oil price shocks insignificantly retard economic growth while oil price itself significantly improves it and FDI.

Olanipekun (2016) empirically studied the relationship between oil price movements, exchange rate, external reserve and real GDP in Nigeria with a quarterly data from 1971Q1 to 2014Q4. It was found that the transmission channel of crude oil price shocks to economic performance is through external reserves, exchange rate and inflation, and overall, the study showed that negative oil price shocks pose deleterious effect on macroeconomic variables in Nigeria. Yusuf (2015) also investigated the impact of oil price shocks on economic growth of Nigeria by evaluating the long-run relationship among the variables; oil price, exchange rate, agricultural output, unrest and economic growth, between 1970Q1 and 2011Q4. It was found that there is a positive and negative impact of oil price shocks and unrest to economic growth, which means long-run impact exists. The study concluded that oil price, exchange rate, agricultural output and unrest contained some useful predicting information for Nigeria's economic growth path.

On a similar note, Omojolaibi (2013) also studied the macroeconomic dynamics of domestic price level, economic output, money supply and oil price in Nigeria, which covers the data from 1985:q1 to 2010:q4. The results suggest that domestic shocks and policies, instead of oil-boom should be blamed for inflation. It was also found that money shocks are the main cause of GDP fluctuations, albeit oil shocks have significant positive impacts on economic output. Furthermore, Mordi&Adebisi (2010) analyzed the asymmetric impact of oil shocks on

output and price in a unifying model, which they found to be present, and also concluded that Oil price changes play a significant role in determining the variance decompositions of output and prices. Their study utilized data from 1999:01 to 2008:12 of variables; Gross domestic product, consumer price index, monetary aggregate, deposit rate, real exchange rate, and oil prices asymmetry and all-share index.

Many other studies however, employed the Vector Error Correction Mechanism (VECM) together with the Johansen Cointegration, among which are;

Iyeli and Utting (2017) examined the effect of exchange rate volatility on Economic Growth in Nigeria by formulating a model comprising of Real GDP, Exchange Rate (EXR), Balance of Payment (BOP) Oil Revenue (OREV) and inflation (INF), with a data covering a span of 44 years (1970-2014). Results from the parsimonious model show that OREV and EXR are positively related to GDP. Also, it was also implied in the study that exchange rate volatility and oil revenue contributes positively to GDP in the long run. Likewise, Ogboru et al (2017) used times series data on crude oil price, inflation rate, real effective exchange rate, fuel pump price and GDP growth rate from 1986 to 2015, to empirically examined the impact of changes in crude oil prices on economic growth in Nigeria. It was found that a positive and unidirectional relationship that runs from crude oil prices to GDP growth rates exists, there was also evidence of Cointegration among variables. The study concluded that crude oil price exerts positive influence on the economic growth of Nigeria. On the same modelling note, Ogundipe et al (2014) used annual data covering the period 1970 to 2011 to examine the effects of oil price, external reserves and interest rate on exchange rate volatility in Nigeria. After the necessary empirical analyses, the results signified that a proportionate change in oil price will lead to a more than proportionate change in exchange rate volatility. Busayo's (2013) findings, after estimating time series data from 1970 – 2011, revealed that oil price is elastic in relation to exchange rate volatility in the long run. A

proportionate change in oil price leads to a more than proportionate change in exchange rate volatility by 2.86, and the t-statistic of his adopted model showed that the co-efficient is statistically significant. The economic implication is that a change in international oil price will have a greater effect than expected on exchange rate volatility here in Nigeria.

It is observed that some researchers made use of the General Autoregressive Conditional Heteroskedasticity (GARCH) estimation model in their studies;

Oyinlola (2018) modelled the volatility persistence and asymmetry of naira-dollar exchange rate in interbank and Bureau de Change (BDC) using monthly data between January 2004 and November 2017. The study employed Generalized Autoregressive Conditional Heteroscedasticity [GARCH (1,1)], Threshold GARCH [TGARCH (1,1)] and Exponential GARCH [EGARCH (1,1)]. The period of study covers from January 2004 to November 2017. The findings showed that persistence is generally explosive in the BDC market as compared to interbank market where the persistence was high but not explosive especially under asymmetric models.

Deebom and Isaac's (2017) study was targeted at modeling price volatility and the risk-return related to crude oil export in Nigerian crude oil market using the first order asymmetric and symmetric univariate Generalized Autoregressive Conditional Heteroscedasticity (GARCH) family model in three distributional assumptions namely, Normal, student's-t and generalized error distribution. The data for the study was extracted from the Central Bank of Nigeria online statistical database starting from January, 1987 to June, and 2017. The results from the statistical analysis reveal that the markets were optimistic of their investment and other trade related activities. Sequel to that, there were high probabilities of gains than losses. From their estimations, they realized that first order symmetric GARCH model (GARCH, (1,1) in student's-t error assumption gave a better fit than the first order Asymmetric GARCH model (EGARCH (1,1)) in Normal error distributional assumptions.

Abdulkareem and Kilishi (2016) employed GARCH model and its variants (GARCH-M, EGARCH and TGARCH) with daily, monthly and quarterly data of Crude oil prices, real GDP, exchange rates and interest rate, to give an analytical insight on modelling macroeconomic and oil price volatility in Nigeria. The study revealed that the asymmetric models TGARCH and EGARCH outperform the symmetric models GARCH (1 1) and GARCH – M, meaning that the asymmetric effects are important in modeling the volatility in Nigeria. The oil price volatility significantly impacts on the volatility of all the variables considered, which implies that it is a major source of macroeconomic volatility, hence, the Nigerian economy is vulnerable to both internal shocks and external shocks. Similarly, Omorokunwa (2015) empirically estimated a model that helps to explain the behaviour of oil prices volatility, movements in stock prices and real exchange rates in Nigeria using quarterly data from 1990 to 2012. Statistical and econometric techniques such as the Error Correction Mechanism (ECM) and the Bi-variate GARCH model were used to test for the relationships and to check if volatility in oil prices are transmitted to stock prices in Nigeria. The GARCH results show persistence in volatility for the individual variables and transmission of volatility for the variables. The study showed that oil price volatility generates and stimulates stock prices volatility in Nigeria.

ThankGodand Maxwell (2013) investigated the time-series relationship on the impact of oil price volatility on macroeconomic activity in Nigeria using exponential generalized autoregressive conditional heteroskedasticity (EGARCH), impulse response function and lag-augmented VAR (LA-VAR) models. Annual data spanning from 1970 to 2010 was employed for variables including Inflation rate, Real effective exchange rate, real GDP, interest rate and government expenditure. From the estimation results, evidence was found that there is a unidirectional relationship exists between the interest rate, exchange rate and oil prices, with

the direction from oil prices to both exchange rate and the interest rate. However, a significant relationship between oil prices and real GDP was not found.

Also, Adeniyi et al (2012) used the GARCH and EGARCH models to gauge the influence of oil prices on the nominal exchange rate and to examine the oil price- exchange rate nexus for Nigeria deploying daily observation spanning the period from 2nd January, 2009 to 28th September, 2010. Their findings revealed that as for the GARCH models, it indicated that a 100% increase in oil price returns would lead to a 1.073% appreciation of the naira with respect to the US dollar, while for the EGARCH model the magnitude of response is slightly higher at about 1.140%. They also posit that whatever the case may be, be it a positive or negative oil shocks both have an asymmetric effect on the volatility of Nigeria's nominal exchange rate. In conclusion, there is a low or no significant relationship between oil price shifts and exchange rate. Again, Madueme and Nwosu (2010) estimated the impact of oil price shock on macroeconomic variables in Nigeria in order to ascertain the shock impact on key variables using data from 1970 to 2008. The regression result showed that during that period, the capital expenditure of the Federal Government, exchange rate and crude oil prices, contributed positively to the growth of the Nigeria

However, despite the reported loopholes in the application of the Least squares regression techniques, some recent works still employ it in their studies. For example;

Broni-Bediako et al (2018) empirically investigated the economic effects of oil price volatility on Nigeria's economy using some macroeconomic indicators such as gross domestic product (GDP), exchange rate (EXR), interest rate (INR), Foreign Direct Investment (FDI), and balance of payment (BOP) by using the Ordinary Least Square (OLS). The data set duration was from 1990 to 2015. The result of the study shows that the macroeconomic variables respond to changes in the price of oil (volatility), although at varying extent/degrees. It was found that oil price volatility is linearly related to the

macroeconomic variables investigated, and that price volatility has an effect on interest rate, balance of payment, gross domestic product and foreign direct investment.

Ogiriki and Werigbelegha (2017) examined the relationship between exchange rate fluctuations and the performance of the Nigerian economy using the Multivariate linear regression model for the analyses. Gross Domestic Product Rate was used as the dependent variable to measure the performance of the Nigerian economy; whereas, Exchange Rate (EXR); Interest Rate (INT) and Inflation Rate (INFR) were used as the explanatory variables to measure exchange rate fluctuations. Data used for the variables covered the period of 27 years (1990-2016). The results suggest that exchange rate has a positive insignificant relationship with GDP growth rate of Nigeria, and further reveals that interest rate and inflation rate have negative insignificant relationship with the performance of the Nigerian economy. Likewise, Nwoba et al. (2017) study found that fallen oil price has a significant effect on the Nigerian economy and has impacted negatively on it when the variables; Crude oil price, Foreign Exchange Earnings, aggregate expenditure, budget servicing and public sector employment rate were analyzed over the period of five years (2011-2015) using Regression and some hypothesis tests. Specifically, it was found that Oil price has a significant effect on foreign exchange earnings, and variations in government savings. However, there is no significant relationship between fallen oil prices and aggregate expenditure and also debt servicing. In the same vein, Nwanna and Eyedayi (2016) found that there is a positive and significant relationship between oil price and economic growth in Nigeria, and that Oil price itself has a positive impact on the economy, but not oil price volatility, using annual data from 1980 to 2014 for Crude oil prices, real GDP, Per-Capita Income, real foreign exchange rate, government revenue, external foreign reserves and capital importation

Also, Osigwe's (2015) study evaluated the effects of exchange rate fluctuations on crude oil price as well as on economic performance, simultaneously, by employing the ordinary least square and the two stage least squares estimation techniques on the variables; Gross domestic product of Nigeria, Oil price, Real exchange rate, Trade openness, Inflation, Terms of trade, World gross domestic product, and World crude oil production. From Error correction model, it was found that the relationship between the real exchange rate and oil price is found to be negative; The relationship between the world crude oil production and the oil price is negative which satisfies a priori expectation. The study found that real exchange rate and rise in oil price have positive effects on the Nigeria's economic performance by 1.2% and 4% respectively. Taiwo et al (2012) found out that Crude oil price, stock price and exchange rate have significant influence on the growth of the Nigeria economy when they examined the data from 1980-2010 of Oil prices, Gross domestic product, Stock prices, exchange rates, and Interest rate.

2.4.3 Empirical Literature Gaps

From the empirical literature reviewed above, the following gaps have been identified:

- None of the study has investigated the influence of Oil price volatility during the recessionary and non-recessionary periods in Nigeria in order to assess the asymmetric response of macroeconomic variables in Nigeria.
- Empirical evidence of modeling oil price volatility in Nigeria, so far, uses traditional GARCH model which usually over-estimate conditional variance if the series is characterized with break. Thus, this study is the first of its kind to have attempted to fit the oil price with Markov-Switching GARCH that allows for time varying variances across regimes.

- No prior study has investigated the effect of the Niger Delta militants' activities on the oil production in Nigeria, and on the macroeconomic performance of Nigeria as a whole
- Almost all empirical studies in Nigeria that explore oil price shock and macroeconomic responses use traditional identification scheme of short run/recursive identification or long run restriction or a combination of the two schemes. This is the first attempt to empirically establish evidence of oil price shock using sign-identified SVAR

CHAPTER THREE RESEARH METHODOLOGY

3.1 Introduction

The data for the study is quarterly series and are obtained from the CBN Data Bank. The study adopts quarterly observations for the period 1986 to 2017, making cumulatively 124 observations. Quarterly series are preferred as it increases the data points and provides greater degrees of freedom. A proper definition of oil prices is a difficult task. In this study however, oil prices are used in real terms, taking the ratio of the average world nominal oil price in US dollars to the US Consumer Price Index extracted from CBN Data Bank. The definition of oil prices adopted for the study is symmetric oil price growth rates as well as asymmetric definition of oil price changes.

3.2 Data Measurement and Variable Description

The study examines the impact of oil price volatility on Gross Domestic Product, Exchange Rate and Inflation rate in Nigeria. Quarterly data spanning from 1986:Q1 to 2017:Q4, a total of 124 observations, were employed using SVAR and GARCH Models respectively. It is noteworthy that the variables are continuous and are defined as follows;

Table 3.1 Variables' Definition, Measurement and Sources

Variables	Definition/Measurement	Sources of Data
GDP	Gross Domestic Product in real terms at constant prices. It is measured in Billion US dollars	Data sourced from the Central Bank of Nigeria data bank
COP	Crude Oil Price. It is measured is US dollars per barrel	Data sourced from the Central Bank of Nigeria data bank
CPI	Consumer Price Index. It is the country's all price index that measures the Inflation rate; i.e. price changes in basket of goods and services	Data sourced from the Central Bank of Nigeria data bank
EXR	Real Exchange Rates; nominal exchange rate divided by the price deflator. It's in country's currency units to a US dollar after relative price adjustments	Data sourced from the Central Bank of Nigeria data bank
OPG	Oil Production Gap: This is the difference between the potential oil production (OPEC quota given to Nigeria) and actual oil production capacity of Nigeria. It is measured in quantity of barrel pay day (bpd). It is conceptualized as a proxy for the Niger-Delta militant activities	Data on potential oil production is collected from official website of OPEC

Source: Authors Compilation

3.3 Model Specification

This study uses:

- i Sign-identified Structural Vector Autoregression (SVAR) model and
- ii A two-family model of Markov-Regime Generalized Autoregressive Model (MS-GARCH)

3.3.1 Specification of SVAR Model

Generally, a linear VAR Model is specified as:

$$Y_t = m + A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + \varepsilon_t \dots\dots\dots (3.1)$$

Equation (3.1) specifies VAR (p) process, where A_i ($i = 1, 2, \dots, p$) are $k \times k$ matrices of coefficients, m is a $k \times 1$ vector of constants and ε_t is a vector of white noise process. The easiest way to appreciate the feature of VAR is to specify a sample VAR. consider a simple VAR where $k=2$ and $p=1$. This gives:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} m_1 \\ m_2 \end{pmatrix} + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \dots\dots\dots (3.2)$$

$$y_t = v + A y_{t-1} + U_t \dots\dots\dots (3.3)$$

More explicitly, this can be written as:

$$y_t = m_1 + a_{11} y_{1,t-1} + a_{12} y_{2,t-1} + \varepsilon_{1t} \dots\dots\dots (3.4)$$

$$y_t = m_2 + a_{21} y_{1,t-1} + a_{22} y_{2,t-1} + \varepsilon_{2t} \dots\dots\dots (3.5)$$

Thus, each variable in VAR is expressed as a linear combination of lagged values of itself and lagged values of all other variables in the group. The behavior of y depends on the properties of the A matrix. If the Eigen values and Eigen vectors of A matrix are:

$$a = \begin{pmatrix} \lambda_1 & \mathbf{0} \\ \mathbf{0} & \lambda_2 \end{pmatrix} \quad C = \begin{pmatrix} \vdots & \vdots \\ c_1 & c_2 \\ \vdots & \vdots \end{pmatrix}$$

Provided the Eigen values are distinct, the Eigen vectors will be linearly independent and C will be nonsingular. It then follows that;

$$C^{-1} AC = \text{and } A = C C^{-1} \dots\dots\dots(3.6)$$

Defining a new vector Z_t as:

$$Z_t = C^{-1}y_t \text{ or } y_t = CZ_t \dots\dots\dots(3.7)$$

The process of pre-multiplying (3.2) by C^{-1} and simplifying gives:

$$Z_t = m^* + Z_{t-1} + \eta_t \dots\dots\dots(3.8)$$

Where $m^* = C^{-1}m$ and $\eta_t = C^{-1}\varepsilon_t$.

Thus,

$$Z_{1t} = m_1^* + \lambda_1 Z_{1,t-1} + \eta_{1t} \dots\dots\dots(3.9)$$

$$Z_{2t} = m_2^* + \lambda_2 Z_{2,t-1} + \eta_{2t} \dots\dots\dots(3.10)$$

Each Z variable follows a separate AR (1) process and is stationary I (0), if the Eigen value has modulus less than 1; is a random walk with drift I (1), if the Eigen value is 1; and is explosive, if the Eigen value exceeds 1 in numerical value. Finally, it is important to look for the cointegrating relation. Using equation (3.4) such relation can readily be found. The second bottom row in equation (3.4) gives:

$$Z_{2t} = c^{(2)}y_t \dots\dots\dots(3.11)$$

Where $c^{(2)}$ is the bottom row in C^{-1} . Thus, z_2 is the linear combination of I(1) variables but is itself a stationary I(0) variable. The co-integrating vector annihilates the I(1) component in y_t .

The model of this study is specified as:

$$\Delta GDP_t = \sum_{i=1}^L \alpha_{11}^i \Delta GDP_{t-i} + \alpha_{12}^0 \Delta EXR_t + \sum_{i=1}^L \alpha_{12}^i \Delta EXR_{t-i} + \alpha_{13}^0 \Delta CPI_t + \sum_{i=1}^L \alpha_{13}^i \Delta CPI_{t-1} + \sum_{i=1}^L \alpha_{15}^0 \Delta COP_t + \sum_{i=1}^L \alpha_{15}^i \Delta COP_{t-i} + \varepsilon_{1t}$$

$$\begin{aligned}\Delta EXR_t &= \sum_{i=1}^L \alpha_{21}^i = \Delta EXR_{t-i} + \alpha_{22}^0 \Delta GDP_t + \sum_{i=1}^L \alpha_{22}^i \Delta GDP_{t-i} + \alpha_{23}^0 \Delta CPI_t + \sum_{i=1}^L \alpha_{23}^i \Delta CPI_{t-i} + \alpha_{25}^0 COP_t + \sum_{i=1}^L \alpha_{25}^i \Delta COP_{t-i} + \varepsilon_{2t} \\ \Delta CPI_t &= \sum_{i=1}^L \alpha_{31}^i \Delta CPI_{t-i} + \alpha_{32}^0 \Delta GDP_t + \sum_{i=1}^L \alpha_{32}^i \Delta GDP_{t-i} + \alpha_{33}^0 \Delta EXR_t + \sum_{i=1}^L \alpha_{33}^i \Delta EXR_{t-i} + \sum_{i=1}^L \alpha_{35}^i \Delta COP_{t-i} + \varepsilon_{3t} \\ \Delta COP_t &= \sum_{i=1}^L \alpha_{51}^i \Delta COP_{t-i} + \alpha_{52}^0 \Delta GDP_t + \sum_{i=1}^L \alpha_{52}^i \Delta GDP_{t-i} + \alpha_{53}^0 \Delta EXR_t + \sum_{i=1}^L \alpha_{53}^i \Delta EXR_{t-i} + \alpha_{54}^0 \Delta CPI_t + \sum_{i=1}^L \alpha_{54}^i \Delta CPI_{t-i} + \varepsilon_{4t}\end{aligned}$$

Where:

GDP is Real Gross Domestic Product; CPI is Consumer Price Index; and COP is Crude Oil Prices. The variables are time series variables and the data sourced from CBN bulletin and OPEC bulletin respectively.

According to Simatele (2004), deviations may result from changing the systematic component from exogenous shocks. These deviations can be used as a basis for observing the responses of the selected macroeconomic variables to the changes in the price of oil price. What is conventionally revealing is the fact that the Cholesky decomposition imposes a recursive causal structure from the top variables to the bottom variables and vice-versa to transform the system innovations into contemporaneously uncorrelated shocks. Thus, following Lutkepohl(2005), for a K -dimensional stationary SVAR (p), the useful theoretical remark is that:

$$\theta_{jk,i} = 0, \forall j \neq k, i = 1, 2, \dots, \theta_{jk,i} = 0, \forall i = 1, \dots, p(k-1) \quad (3.12)$$

In effect, the identifying restriction implies that if the first $[pK - p]$ response of variable j to an impulse in variable k is zero, then all the following responses are zero. Also, variable k does not cause variable j if $\theta_{jk,i} = 0, i = 1, 2, \dots$

The crucial issue in estimation of structural model is always the identification of the empirical model.

Consider a K - dimensional time series $y_t=1, \dots, T$. We postulate that y_t can be approximated by a vector autoregression of finite order p . Our objective is to learn about the parameters of the structural vector autoregressive model

$$B_0 y_t = B_1 y_{t-1} + \dots + B_p y_{t-p} + \mu_t \quad (3.13)$$

Where μ_t denotes a mean zero serially uncorrelated error term, also referred to as a structural innovation or structural shock. The error term is assumed to be unconditionally homoskedastic, unless noted otherwise. All deterministic regressors have been suppressed for notational convenience. Equivalently the model can be written more compactly as

$$B(L)y_t = \mu_t \quad (3.14)$$

Where $B(L) = B_0 - B_1L - B_2L^2 - \dots - B_pL^p$ is the autoregressive lag order polynomial. The variance-covariance matrix of the structural error term is typically normalized such that:

$$E(\mu_t \mu_t^i) = \sum_{\mu} = I_k \quad (3.15)$$

This means, first, that there are as many structural shocks as variables in the model. Second, structural shocks by definition are mutually uncorrelated, which implies that \sum_{μ} is diagonal. Third, we normalize the variance of all structural shocks to unity. The latter normalization does not involve a loss of generality, as long as the diagonal elements of B_0 remain unrestricted.

Also, explicitly with respect to the sign restrictions which will be discussed in the subsequent section (3.3.1.2), the SVAR model is adopted for this study because it is theoretic in nature, whereby it adopts economic theory for its analysis. Skepticisms has been raised by empirical macroeconomists in employing other forms of restrictions because they are perceived to be too sensitive to ordering and rarely fit into economic theory. It also has high forecasting power relative to large structural models. Also, as a common virtue of SVAR, the variables are all endogenous, hence, bypasses the decision as to what contemporaneous variables are exogenous.

The study is also interested in capturing the effect of Niger Delta militants' activities on oil production in Nigeria. An exogenous variable, x_t will be incorporated in the VAR model to show this effect. Therefore, the model will be re-specified as;

$$y_t = m + Ay_{t-1} + Bx_t + \varepsilon_t \dots \dots \dots (3.14)$$

x_t is a difference between the actual oil production level and the potential oil production level. It is an exogenous variable in the VAR specification representing the activities of the Niger-Delta militants.

3.3.1.1 Estimation of SVAR Models

VAR models can be estimated by standard methods. Unrestricted least squares (LS), generalized least squares (GLS), bias-corrected least squares and maximum likelihood (ML) methods are the common classical method of estimation. For the purpose of this research, we intend to fit our data with the aforementioned methods of estimation. The data generating process will govern the selection of the most appropriate method of estimation of models. It must be maintained that, in this research, we intend to use a stationary process so that the data generating process of the variables used in the study are subjected to standard transformation process.

3.3.1.2 Lag Selection Criteria

In this study, we will be guided by two methods of determining the optimal size of lags to be included. Sequential testing procedure and information criteria will be used. In Sequential testing procedure, we further utilize the 'Top-down sequential testing' through Wald or LR tests for parameter restriction while the 'Bottom-up sequential testing', we utilize Portmanteau and LM tests to decide the optimal number of lags. The information criteria to be used, on the other hand, are the Akaike Information Criterion (AIC), Hannan-Quinn Criterion (HQC), and Schwarz Information Criterion (SIC).

Residual ARCH Tests

Conditional heteroskedasticity in the VAR innovations does not invalidate the consistency of standard estimators of the VAR slope parameters, as long as the unconditional error variances remain finite. However, it undermines the efficiency of the estimator and affects how we conduct inference about the parameters of interest. Hence, knowing whether the innovations are conditionally heteroskedastic or not is quite important

Time Invariance

An important assumption underlying a standard VAR analysis is the time invariance of the model. As defined earlier, stationarity requires time invariance and unconditional moments. That assumption is not only violated if the stability condition is unsatisfied but may also be violated if the parameters change over time. A wide range of procedures for checking the stability or time invariance of a given model exist. Chow test via LR statistic will be utilized to check whether the parameters of the VAR models are fixed.

3.3.1.5 Tools of Structural Analysis of SVAR Models

Standard SVAR tools of analysis will be used to draw structural inference for the research. In this work, we intend utilize *'impulse response function'*, *'forecast error variance decomposition'*, *'Granger Causality'*, *'in-sample forecast'* and *'out-of-sample forecast'*, *'forecast scenario'*, and *policy counterfactuals*.

Impulse Response Analysis will be used to trace the effect of mutually (un) correlated shocks on the macroeconomic variables of interest and therefore help in identification of dynamic response of the variables to one standard deviation shocks.

Forecast Error Variance Decomposition helps to decompose the contribution of shocks in explaining fluctuations in the macroeconomic variables. The weights of each shocks can be decomposed via prediction mean squared error at various horizons.

We intend to produce forecast scenario to scrutinize the model's predictive power via conditional and unconditional forecast. Thus, the sensitivity of reduced-form SVAR forecasts to hypothetical future events will be evaluated using forecast scenario.

3.3.1.6 Identifying Oil Shock using Sign Restriction

In this study, we propose to employ sign restriction as the scheme for the identification of structural shocks in the SVAR. The rationale for opting this identification is traced to the skepticisms raised by empirical macroeconomist in employing short run and long run restrictions. Following study of fiscal shocks (e.g., Canova and Pappa 2007; Mountford and Uhlig 2009; Pappa 2009), technology shocks (e.g., Dedola and Neri2007), and various other shocks in open economies (e.g., Canova and De Nicolo 2002; Scholl andUhlig 2008), in oil markets (e.g., Baumeister and Peersman 2010; Kilian and Murphy 2011a,b), and in labor markets (e.g., Fujita 2011), we develop and adopt the restrictions as revealed in the table:

Table 3.2 Variables' Definition, Measurement and Sources

STRUCTURAL SHOCKS	IR_{oil}	GDP_{oil}	$EXCR_{oil}$	INF_{oil}	OPG
Oil supply	< 0	≤ 0	-	≤ 0	
Oil demand driven by economic activity	> 0	> 0	-	> 0	
Oil-specific demand	> 0	≤ 0	-	> 0	

From the restrictions imposed in the table, the shape of the impulse response function will be used to identifying the restrictions that meet the economic theory. The fraction of the initial candidate models that satisfy the identifying restriction may be viewed as an indicator of how informative the identifying restrictions are about the structural parameters.

3.3.2 Specification of MS-GARCH Model

We suspect that oil price series is characterized with several structural breaks as already established in the literature {See: Salisu & Fasanya (2013), Olanipekun (2016), Eagle (2017), and Plante&Strickler (2019)}. Thus, traditional GARCH models such as E-GARCH of Nelson (1991), GJR GARCH of Glostelet'al (1993) and TGARCH of Zakoian (1994) are not robust to the presence of breaks in the series. These models are found to over-estimate the conditional variance of the series which has breaks.

Therefore, an appealing contribution in our study is to examine oil price volatility with flexible econometric model of Markov-Switching GARCH. Our attraction towards this framework is that it accommodates series with breaks, exploits discrete changes in volatility of the series across several regimes. In sum, we feel that one reason for specifying MS-GARCH in our study is that we want to analyze the GARCH behavior of oil price in two discrete regimes; the high volatility regime (periods of high oil price fluctuation) and low volatility regime (periods of low oil price fluctuation).

The general MS-GARCH specification is written as;

$$y_t | (s_t = k, \mathcal{I}_{t-1}) \sim \mathcal{D}(0, h_{k,t}, \xi_k), \dots\dots\dots(3.15)$$

Where $\mathcal{D}(0, h_{k,t}, \xi_k)$ is a continuous distribution with zero mean, time varying variance $h_{k,t}$, and additional shape parameters gathered in the vector ξ_k . The variable s_t , defined on the discrete space $\{1, \dots, K\}$ characterizes the Markov-switching GARCH model. The standardized innovation is further defined as;

$$\eta_{k,t} \equiv y_t / h_{k,t}^{1/2} \stackrel{iid}{\sim} \mathcal{D}(0, 1, \xi_k). \dots\dots\dots(3.16)$$

We assume that s_t evolves according to an unobserved first-order ergodic homogenous Markov-chain with $K \times K$ transition probability matrix \mathcal{P}

$$\mathbf{P} \equiv \begin{bmatrix} p_{1,1} & \cdots & p_{1,K} \\ \vdots & \ddots & \vdots \\ p_{K,1} & \cdots & p_{K,K} \end{bmatrix}$$

Where $p_{i,j} \equiv P[s_t = j | s_{t-1} = i]$ is the probability of a transition from state $s_{t-1} = i$ to $s_t = j$. The sum of the probability is 1 and the probability must lie between zero and one. The conditional variance of y_t is assumed to follow a GARCH-type model. Hence, conditionally on regime $s_t = k$, $h_{k,t}$ is available as a function of the past observation, y_{t-1} , past variance $h_{k,t-1}$, and the additional regime-dependent vector of parameters θ_k :

$$h_{k,t} \equiv h(y_{t-1}, h_{k,t-1}, \theta_k) : \dots\dots\dots(3.17)$$

where $h(\cdot)$ is a \mathfrak{F}_{t-1} measurable function that defines the filter for the conditional variance and also ensures its positiveness. In the MSGARCH package, the initial value of the variance recursions, that is $h_{k,1} (k = 1, \dots, K)$, are set equal to the unconditional variance in regime k . Depending on the form of $h(\cdot)$, we obtain different scedastic specifications.

In our study, we propose to use two different conditional distributions; the student t distribution and generalized error distributions. The probability density function of the student t distribution is given as;

$$f_S(\eta; \nu) \equiv \frac{\Gamma(\frac{\nu+1}{2})}{\sqrt{(\nu-2)\pi} \Gamma(\frac{\nu}{2})} \left(1 + \frac{\eta^2}{(\nu-2)}\right)^{-\frac{\nu+1}{2}} \dots\dots\dots(3.18)$$

Equally, generalized error distribution has its probability density function given as'

$$f_{GED}(\eta; \nu) \equiv \frac{\nu e^{-\frac{1}{2}|\eta/\lambda|^\nu}}{\lambda 2^{(1+1/\nu)} \Gamma(1/\nu)}, \quad \lambda \equiv \left(\frac{\Gamma(1/\nu)}{4^{1/\nu} \Gamma(3/\nu)}\right)^{1/2} \dots\dots\dots(3.19)$$

3.3.2.1 Estimation of the MS-GARCH

GARCH models are basically nonlinear and can therefore be estimated using Maximum Likelihood (ML). The likelihood function needs to be specified, in a tractable form, then estimated via the ML techniques. In cases where convergence is not achieved, we intend to use numerical solution of the model to arrive at model parameters.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

The main thrust of the study is established in two-folds. In onefold, the empirical investigation aims to analyze, explore and forecast the volatility of oil price as it affects the behavior of the economy. In this fold, the study aims to estimate two class of volatility models, namely, the traditional GARCH family and Markov-Switching GARCH. In the former class of model, we provide estimate of Exponential GARCH (E-GARCH) following Nelson and Kim (1991) while in the second fold, the study intends to assess the relationship between shock induced from oil price and macroeconomic variables in Nigeria. Thus, the chapter is guided by two cardinal objectives which are related to the research questions raised. To accomplish these tasks, the research estimates econometric models in which the shocks from oil price are analyzed and volatility from oil are incorporated into the macroeconomic dynamic of Nigeria. All variables in the data set, except the interest rate and oil production gap, are the natural log of the original data series times 100 in line with the transformations of the data in most of the literature of the Structural Vector Autoregression (SVAR). See; Kilian, L (2009), Kilian, L. and Park, C.(2009), Christian Danne (2015).

4.2 Oil Price: Volatility Modelling and Forecasting

4.2.1 Descriptive Statistics of the Daily Oil Series

The key statistics of interest are the mean, standard deviation, minimum value and maximum value. Additionally, kurtosis and skewness should also be interpreted. Lastly, measure of normality via Jacque-Bera should be interpreted to assess the nature of the distribution of the daily oil price.

Table 4.1: Descriptive Summary of Daily Return Series of Oil

Parameters	Estimates
Observation	8408
Mean	0.000142
Maximum	0.094622
Minimum	-0.096342
Std. Dev.	0.013142
Skewness	-0.0097562
Kurtosis	9.86
Jarque-Bera	9000
Probability	0.0000

Source: Computed by the researcher using R-Software version 3.6.1(2019)

The estimate of mean of the daily oil price is approximately 0.0142% with the standard deviation of approximately 1.3%. As the standard deviation of the daily oil price is much bigger than the size of the mean of the oil price series, one can comfortably assert that there is evidence of volatility in the daily oil price. Thus, there is volatility clustering associated with the daily return series of oil price. The minimum and maximum values of the daily return series of oil price are respectively, -0.096342 and 0.094622, which are approximately 9%. Evaluating the information at the tail of the distribution, the kurtosis is 9.86 which is in excess of 3, depicting that the daily return series of oil price is contains lot of information at its distribution. So, there is presence of fat tails in the distribution of the series. Additionally, the measure of symmetry is computed to be negative, -0.0097562 which suggests that the distribution of the daily return series of oil price is left-skewed. Thus, the distribution of the non-normal, indicting *student t* distribution may outperform normal distribution in parameter fitting. Assessing the formal test of normality of the daily return series of oil price via Jarque-Bera statistic, we can say that with high probability that the series is far from being normal as the test statistic indicate 9000 with a probability of 0.0000.

4.2.2 Analysis of Oil Price: Evidence of Volatility Clustering

To analyze the volatility of a series, we start by checking for evidence of *Volatility Clustering*; where “*bunch of high volatility is followed by another bunch of high volatility*”. Thus, as it is earlier established that the return series of oil is assumed to be characterized

by non-normality in the series, the study explores visual behaviors of the series. To have a deeper understanding of the true Data Generating Process (DGP), we provide some exploratory analysis¹.

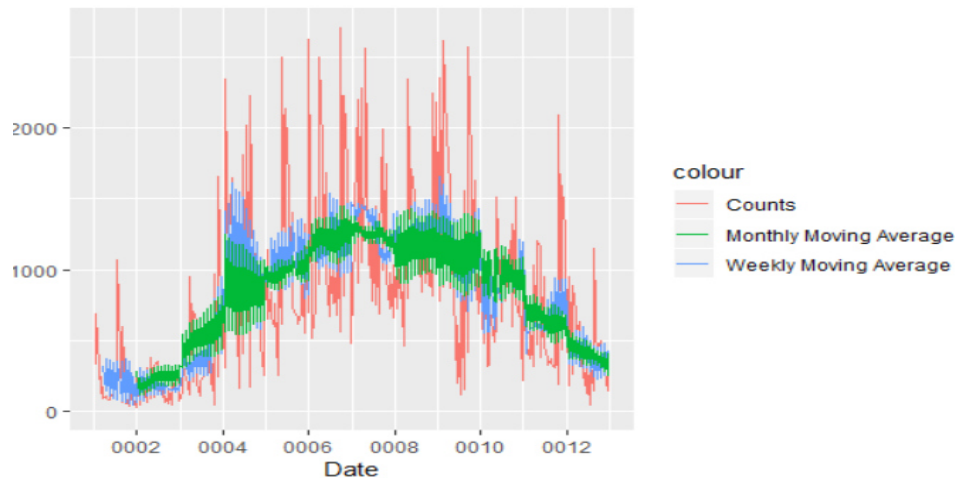


Figure 4.1: Weighted Averages of Daily Series of Oil Price
Source: Generated by the Author using R-Software 36.1. (2019)

Figure 4.1 presents the plot of the daily oil price series which is weighted by monthly and weekly averages. It can be deduced from the visual display of the series that there are possible number of spikes that characterize the trending behavior of the series. Additionally, one can see that there are several episodes of fluctuations which suggest breaks in the series. This is an informal test for nonlinearity in the series and further evidence of using nonlinear models that can extract the true information contained in the series. Another apparent message from the figure is the presence of possible discrete regimes in the series. This may informally suggest that the parameters of the volatility model are regime dependent. Literally, the possible number of breaks in the daily series of oil indicates that there might be low oil price volatility and high oil price volatility in the series. In sum, we are gradually building evidence of estimating regime dependent volatility model, Markov-Switching GARCH (MS-GARCH).

¹ We utilize 'ggplot2' package in R software to produce the plots. The codes are obtained from Hadley Wickham and Thomas Mailund

4.2.3 Estimates of MS-GARCH and E-GARCH: Analysis of the Volatility

The plot of the time series is presented in Figure 4.1. Well-known stylized facts observed in financial time series, such as volatility clustering and presence of outliers, are evident from Figure 4.1 (see, e.g., McNeil et al. 2015). Furthermore, we also note that large (absolute) returns are more frequent at the start (1990 -1993) and at the end (1997-2000) of the sample, than in the middle (1993-1997). This suggests that the conditional variance is time-varying according to a regime-switching specification.

For the sake of illustration, we consider the asymmetric two-state MSGARCH model implemented by Ardia and Mullen et al. (2011, Sec. 5). This is an extension of the MSGARCH model introduced in Haas et al. (2004a), where a GJR variance specification with a Student-t distribution is assumed in each regime.

The study reports the results of the estimation of the two models, the two-regime MS-GARCH and the E-GARCH. Based on the evidence of structural breaks suspected in the daily return series of the oil price, the study investigates the possible bias in the estimates of variance parameters.

Table 4.2: Single-Regime Exponential GARCH (E-GARCH)

<i>Specification type:</i>	<i>Single-regime</i>			
<i>Specification name:</i>	<i>eGARCH_norm</i>			
<i>Number of parameters in each variance model:</i>	4			
<i>Number of parameters in each distribution:</i>	0			
<i>Fitted parameters:</i>	<i>Estimate</i>	<i>Std. Error</i>	<i>t value</i>	<i>Pr(> t)</i>
<i>alpha0_1</i>	0.0090	0.0045	1.9973	2.289e-02
<i>alpha1_1</i>	0.1893	0.0375	5.0479	2.234e-07
<i>alpha2_1</i>	-0.0984	0.0173	-5.6853	6.528e-09
<i>beta_1</i>	0.9243	0.0189	48.8532	<1e-16
<i>LL:</i>	-3459.7876			
<i>AIC:</i>	6927.5751			
<i>BIC:</i>	6950.8713			

Source: Computed by the researcher using R-Software version 3.6.1(2019)

Table 4.3: Two-Regime Markov Switching GARCH

<i>Specification type:</i>	<i>Markov-switching</i>			
<i>Specification name:</i>	<i>gjrGARCH_stdgjrGARCH_std</i>			
<i>Number of parameters in each variance model:</i>	<i>4 4</i>			
<i>Number of parameters in each distribution:</i>	<i>1 1</i>			
<i>Fixed parameters</i>	<i>None</i>			
<i>Across regime constrained parameters:</i>	<i>Nu</i>			
<i>Fitted parameters:</i>	<i>Estimate</i>	<i>Std. Error</i>	<i>t value</i>	<i>Pr(> t)</i>
<i>alpha0_1</i>	<i>0.2071</i>	<i>0.0488</i>	<i>4.2432</i>	<i>1.102e-05</i>
<i>alpha1_1</i>	<i>0.0005</i>	<i>0.0088</i>	<i>0.0569</i>	<i>4.773e-01</i>
<i>alpha2_1</i>	<i>0.2137</i>	<i>0.0619</i>	<i>3.4505</i>	<i>2.798e-04</i>
<i>beta_1</i>	<i>0.5264</i>	<i>0.0995</i>	<i>5.2921</i>	<i>6.045e-08</i>
<i>nu_1</i>	<i>9.2468</i>	<i>1.3292</i>	<i>6.9569</i>	<i>1.739e-12</i>
<i>alpha0_2</i>	<i>0.0922</i>	<i>0.0349</i>	<i>2.6397</i>	<i>4.149e-03</i>
<i>alpha1_2</i>	<i>0.0052</i>	<i>0.0169</i>	<i>0.3050</i>	<i>3.802e-01</i>
<i>alpha2_2</i>	<i>0.1516</i>	<i>0.0381</i>	<i>3.9771</i>	<i>3.488e-05</i>
<i>beta_2</i>	<i>0.8716</i>	<i>0.0354</i>	<i>24.6380</i>	<i><1e-16</i>
<i>P_1_1</i>	<i>0.9977</i>	<i>0.0014</i>	<i>701.8429</i>	<i><1e-16</i>
<i>P_2_1</i>	<i>0.0027</i>	<i>0.0017</i>	<i>1.6006</i>	<i>5.473e-02</i>
<i>Transition matrix:</i>				
	<i>t+1 k=1</i>	<i>t+1 k=2</i>		
<i>t k=1</i>	<i>0.9977</i>	<i>0.0023</i>		
<i>t k=2</i>	<i>0.0027</i>	<i>0.9973</i>		
<i>Stable probabilities:</i>				
<i>State 1</i>	<i>0.5407</i>			
<i>State 2</i>	<i>0.4593</i>			
<i>LL:</i>	<i>-3350.8467</i>			
<i>AIC:</i>	<i>6723.6934</i>			
<i>BIC:</i>	<i>6787.7579</i>			

Source: Computed by the researcher using R-Software version 3.6.1(2019)

From the estimates in table 4.3, we see that parameter estimates indicate that the evolution of the volatility process is heterogeneous across the two regimes. Indeed, we first note that the two regimes report different unconditional volatility levels (**11.87 for regime one and 22.04 for regime two**). It is equally noted from the estimates that there is statistically significant different reactions to past negative returns oil price: **0.21** for regime one and **0.15** for regime two. Also, the volatility persistence in the two regimes is different. The first regime reports **0.63** while the second regime reports **0.95**.

In summary, the first regime is characterized by

- low unconditional volatility of oil price

- strong volatility reaction to past negative returns of oil price, and
- low persistence of the volatility process in the oil price.

Differently, the second regime is characterized by:

- high unconditional volatility of oil price
- weak volatility reaction to past negative returns of oil price, and
- high persistence of the volatility process in the oil price.

Clearly, regime one would be perceived by crude oil market as “tranquil market conditions” with low volatility levels, low persistence and high reaction to past negative returns, while regime two as “turbulent market conditions” with high volatility levels and strong persistence. Put differently, the flexibility of the MS-GARCH model allows us to identify discrete regime in the volatility process of the daily oil price. These regimes are characterized with different behavior of the parameters across the regimes. Thus, the study documents evidence of “*low volatility periods in oil prices*” and “*high volatility periods in oil price*”.

From table 4.2, it can be seen that the behavior of the model parameters, the variance and shock, are far from being similar with the parameters reported in table 4.3. The single-regime E-GARCH model overestimates variance parameter, **0.9243**. The study can decidedly argue that there is possible mis-specification in the E-GARCH as it fails to account for the breaks in the oil price series as earlier confirm in section 4.2.1 and 4.2.2.

4.2.4 Forecasting Oil Price: In-sample Fit Criterion

In this section, the study attempts to address one of its principal objectives; forecasting of oil price. Therefore, the study generates forecast and evaluate the performance of the two models, the traditional, single-regime model (E-GARCH) and the two-regime model (MS-GARCH). The study, in line with the forecasting literature, uses Root Mean Square Forecast Error (RMSFE) as a measure of assessing the in-sample fit of the models. We use the

criterion because it has high power of adjustment to the problem of scaling of units of measurement of variables.

Table 4.4 Comparison of Forecast Performance of the Models: Volatility Forecast

<i>Forecast (2019)</i>	<i>MS-GARCH-t</i>	<i>E-GARCH-n</i>
<i>h=1</i>	<u>2.1113</u>	8.1613
<i>h=2</i>	2.1245	8.7640
<i>h=3</i>	2.1329	8.4306
<i>h=4</i>	2.1134	9.7883
<i>h=5</i>	2.0799	5.1457
<i>h=6</i>	2.0151	4.5627
<i>h=7</i>	2.0264	<u>3.0980</u>
<i>h=8</i>	2.0699	3.5830
<i>h=9</i>	2.0235	3.9528
<i>h=10</i>	2.0756	3.4169
<i>h=11</i>	2.0678	3.7212
<i>h=12</i>	2.0073	3.6637

Source: Computed by the researcher using R-Software version 3.6.1(2019)

From the distribution of the forecast presented in table 4.4, the study can decidedly rule superiority of the forecast of volatility of the daily oil price in favor of MS-GARCH. This is noticeable from the table as the size of the RMSFE is comparatively smaller at all forecast horizons. Additionally, we can see that the forecast generated from the MS-GARCH predict the volatility more accurately in the beginning of the forecast horizon. The least value of the RMSFE is **2.1113** at the first horizons. Interestingly, we can see that as the forecast horizon goes deeper in to the future, the accuracy of the MS-GARCH and traditional single-regime E-GARCH improves substantially, with the former recording superior results.

Based on this comparison, the study can infer that failure to account for breaks in the series will definitely produce biased estimates of the volatility. The nonlinearity is induced by outlier, breaks in either mean or variance or both, shifts and shocks. These characteristics are found in the daily oil price, as depicted in figure 4.1, in section 4.2.2.

Table 4.5 Forecast Performance of the Models: Volatility Forecast

Forecast horizon	MSGARCH-n	E-GARCH-n	MSGARCH-t	E-GARCH-t	MSGARCH-sn	E-GARCH-sn
h=1	2.3919	5.9151	2.4428	9.0442	2.4844	10.3011
h=2	2.3221	10.4429	2.4682	8.3254	2.3703	5.9101
h=3	2.3640	4.9963	2.4370	7.8273	2.4624	6.5382
h=4	2.3724	6.6105	2.3427	5.1898	2.4524	6.2482
h=5	2.3833	9.5005	2.4633	9.9616	2.3912	4.5601
h=6	2.3516	6.3168	2.4368	9.2008	2.4162	6.6870
h=7	2.4018	10.1831	2.4169	5.4013	2.4443	7.1864
h=8	2.4169	9.5506	2.3256	6.4852	2.3005	7.7151
h=9	2.3515	10.4554	2.3573	9.6132	2.3514	6.1141
h=10	2.3501	6.8069	2.3763	10.4975	2.3932	6.7378
h=11	2.3971	5.3034	2.3499	9.1142	2.3929	4.9510
h=12	2.4465	6.5394	2.4982	5.4406	2.4617	5.1248

Source: Computed by the researcher using R-Software version 3.6.1(2019)

From the results obtained in table 4.5, the study further re-affirms and buttresses the fitness of the nonlinear models that allow for discrete parameter change, MS-GARCH, and illustrates the inherent bias in the traditional GARCH family, E-GARCH, T-GARCH, GJR-GARCH as long as the series being modelled is characterized with breaks, outliers and regime shifts.

The inferences to be generated as a guide for policy in Nigeria for absorbing shocks and volatility in oil price will be based on the MS-GARCH. Consequently, the smoothed probabilities can be computed from the MS-GARCH and further deduction from the model can be achieved.

In figure 4.2, the smoothed probability of changing from regime 1 to regime 2 is depicted. It can be seen that the size of the probability in the two regimes is comparatively different, with probability of regime 1 being 99% and less than 1% for regime 2. Figure 4.2 displays the smoothed probabilities of being in regime two (high unconditional volatility regime), superimposed on the oil price log-returns (top graph) as well as the filtered volatility of the overall process (bottom graph).

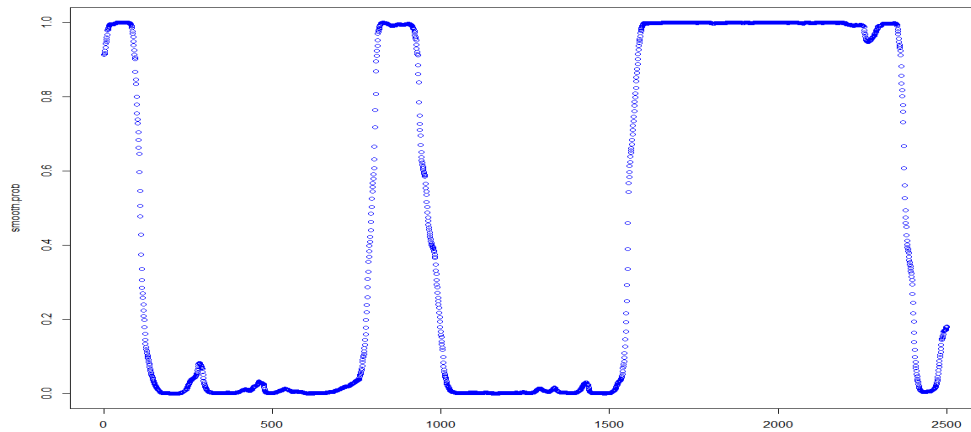


Figure 4.2: Smoothed Probability from MS-GARCH model
Source: Generated by the Author using R-Software version 3.6.1(2019)

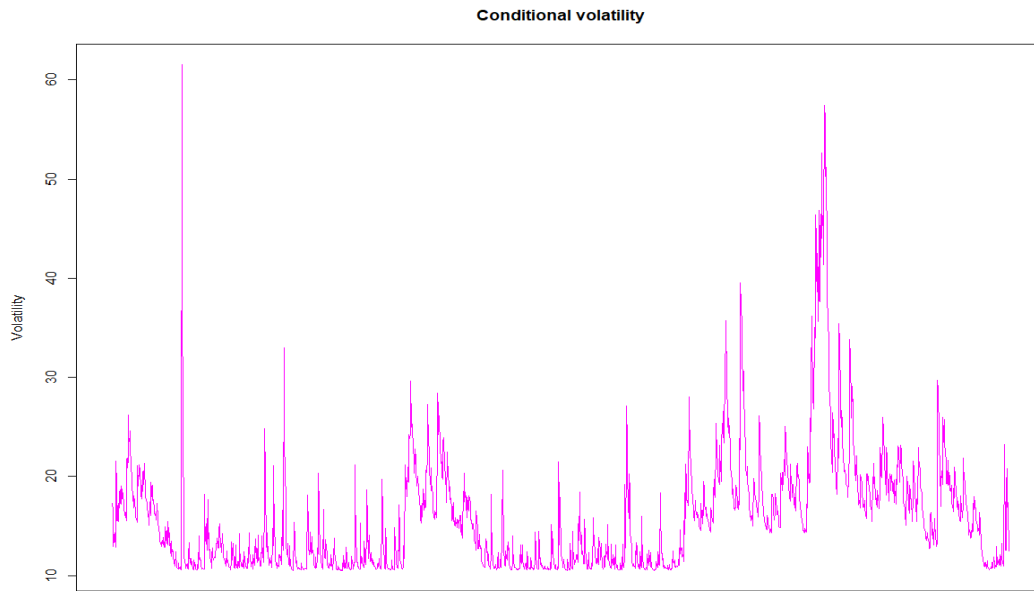


Figure 4.3: Volatility Estimates from MS-GARCH
Source: Generated by the Author using R-Software 3.6.1(2019)

From the plots of the conditional volatility from the MS-GARCH model, it can be seen that the volatility is time-varying. This information cannot be explored or investigated from the single regime volatility models of E-GARCH. This behavior in the series is further evidenced from the empirical literature in Nigeria. Several researchers in Nigeria have established that oil price is not only characterized by structural breaks, but also the volatility in oil price is time-varying.

In conclusion, the study asserts that the oil price series is rather characterized with shifts in regimes (high and low volatility periods) and that estimates from the non-switching models (E-GARCH, T-GARCH and GJR-GARCH) simply produce not only biased estimates of the variance parameter, but inconsistent estimates.

4.3 Oil Price Shock and Macroeconomic Responses: Evidence from Sign-Identified SVAR

In this section, two main objectives of the study will be achieved. The objectives are established on the basis of the methodological contribution and empirical application.

The first objective to be achieved is connected to quantifying the response of key macroeconomic variables in Nigeria induced from global sudden change in identified oil shocks. Thus, the research employs most recent econometric model of shock identification via sign and zero restriction as introduced by Faust (1998), and popularized by Uhlig (2005). This is a contribution to the methodology, as little or no empirical studies in Nigeria so far use a combination of zero and sign restriction to identify the response of macroeconomic variables in Nigeria due to oil shocks. The second objective is related to Niger-Delta militant activity which disrupts oil production in Nigeria. The study develops exogenous variables in the VAR framework to account for the role of Niger-Delta militant.

The study, as explained chapter three, section 3.3, adopts the combination of zero and sign restriction to identify three structural shocks. To recast the identification scheme, the study recalls the information in table 4.6.

Table 4.6: Identification of Structural Shocks

STRUCTURAL SHOCKS	IR_{oil}	GDP_{oil}	$EXCR_{oil}$	INF_{oil}	OPG
Oil supply	< 0	≤ 0	-	≤ 0	
Oil demand driven by economic activity	> 0	> 0	-	> 0	
Oil-specific demand	> 0	≤ 0	-	> 0	

Source: Computed by the researcher using R-Software version 3.6.1(2019)

Therefore, the study intends to examine the response and reaction of the Nigeria's macroeconomic variables, namely, real interest rate, real GDP, real exchange rate, inflation and oil production gap (*IR, GDP, EXCR, INF and OPG*). Following Uhlig (2005), the study utilizes rejection method as preached by the author.

4.3.1 Oil Demand Shock:

The study aims to explore responses of the macroeconomic variables in Nigeria with increase in global economic activity. We examine the shape and changes in the structural impulse response in the figure below. The oil demand shock can be stimulated via several episodes, one of which is boom in the economic activities in the global economy. The lines below extract the posterior impulse responses and plots the resulting impulse responses to oil demand shock. The important macroeconomic variable to be analyzed via its responses is the real GDP because it gives some understanding about the fluctuation in the level of economic activities in the economy.

Structural shock hitting the economy are described in figure 4 where the reaction of the real GDP, real interest rate, exchange rate, GDP deflator, consumer price index and oil production gap is depicted.

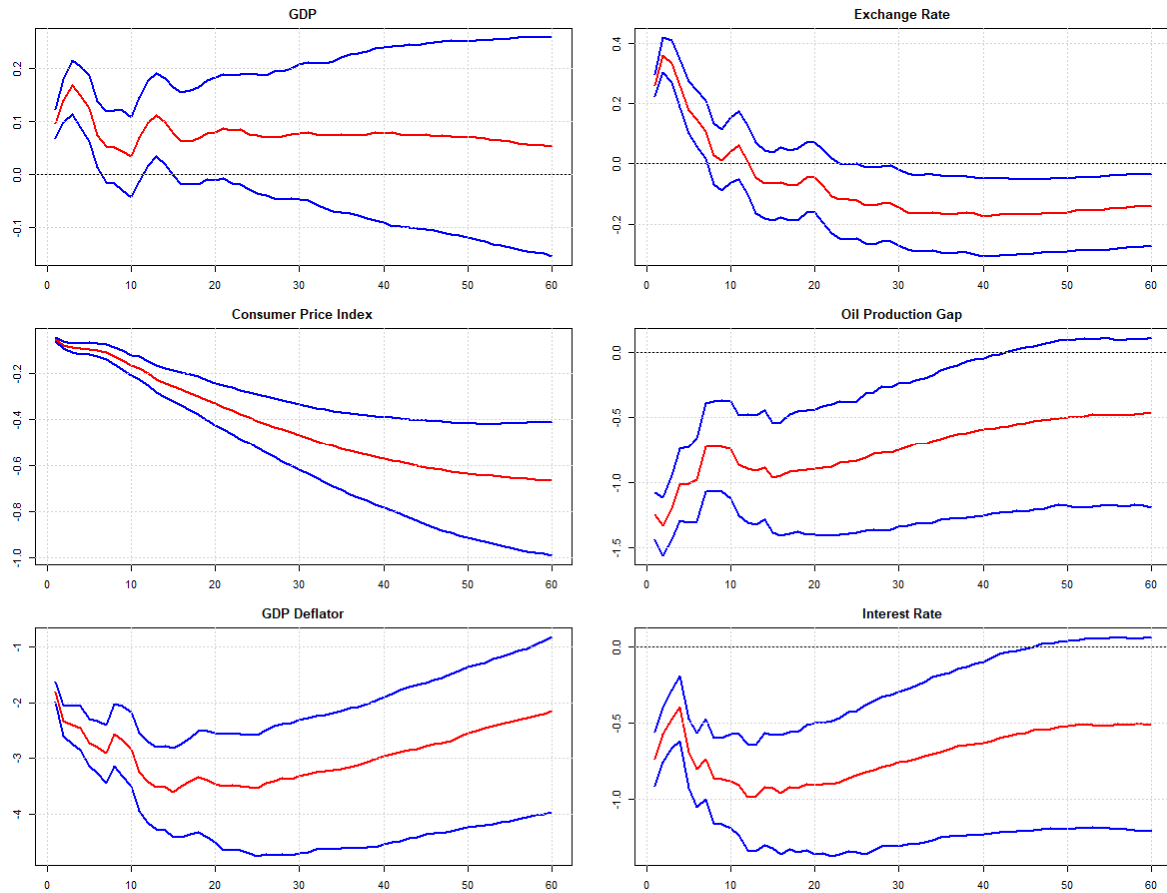


Figure 4.4: Structural Impulse Response to Oil Demand Shock
Source: Generated by the Author using R-Software 3.6.1(2019)

From the top left corner of the figure, we can see that real GDP remain positive throughout the shock scenario, with some fluctuations around the mean value. It is also observed from the figure that there is wide error band around the response of the real GDP which may suggests that the real GDP exhibit uncertainty in its path. The uncertainty in the response of real GDP increases as the time horizon goes further into the future. Thus, with oil demand shock which is induced as a result of increase in global economic activity, Nigeria’s real GDP will exhibit positive response. This can be traced to the rise in the price of oil following positive demand shock.

Exchange rate behaves abnormally by reacting, first as appreciation, then consistently depreciates throughout the shock horizon. Put differently, the exchange rate appreciates

immediately with oil demand shock and then reacts negatively, approaches zero horizon, and further plunge into depreciation of the country's currency.

Consumer price index and GDP deflator react quite in opposite directions. While consumer price index consistently and persistently falls, the GDP deflator raises following oil demand shock. This scenario underscores the importance and dominance of external sector in dynamic interaction of the macroeconomic variables in Nigeria.

It can be seen from the figure 4.4 that oil production gap and real interest rate somehow exhibit similar pattern; persistent negative movement all throughout the shock simulation period. Thus, the sign restriction is left open, unrestricted because there is no prior information or belief to suggest the likely reaction of the variables.

Figure 4.5 illustrates the estimates of forecast error variance decomposition of the structural shock from oil demand. Thus, from the dynamic response of the real GDP in the figure, the study can deduce that real GDP's contribution to the fluctuation of the Nigeria's economy is big-impact movement. The size of the fluctuation in real GDP determines the performance of the economy. Also, as reveal from the figure, exchange rate seems to be important in responding to oil demand shock with almost equal strength as the real GDP. It can be traced to the fact that the Nigeria's economy is best described as a Small-Open Economy (SOE). Thus, exchange rate, which is seen as externally determined, will play significant role in dynamic interaction and reaction of key macroeconomic variables in the Nigerian economy.

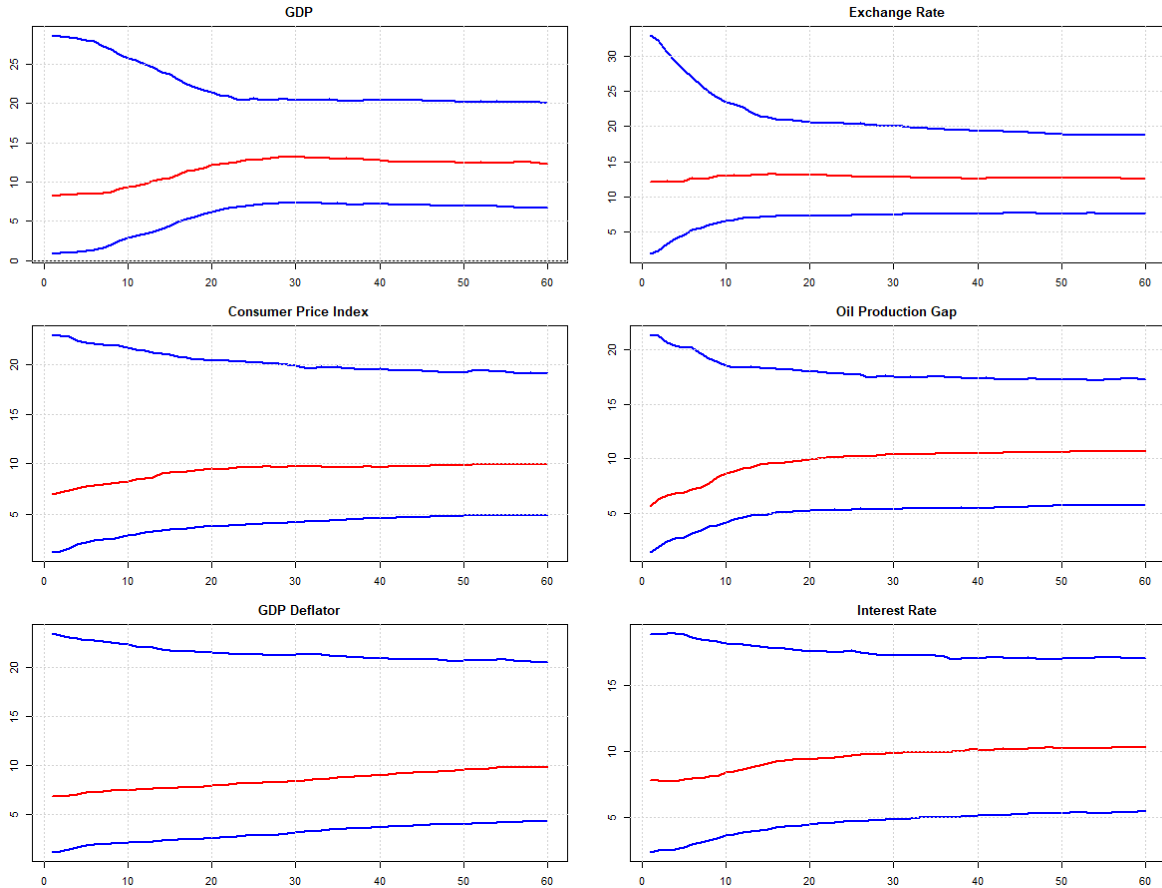


Figure 4.5: Forecast Error Variance Decomposition
Source: Generated by the Author using R-Software 3.6.1(2019)

4.3.2 Oil Supply Shock

In this analysis, the study evaluates shape of the orthogonalized impulse response of the endogenous variables in the system. The model is estimated using the same settings as in Uhlig (2005), i.e. 12 lags, no constant, and 60 steps for the impulse response functions. The algorithms use 200 draws from the posterior and 200 sub-draws for each posterior draw to generate the impulse vectors and the candidate impulse responses to which the rejection algorithm will be applied.

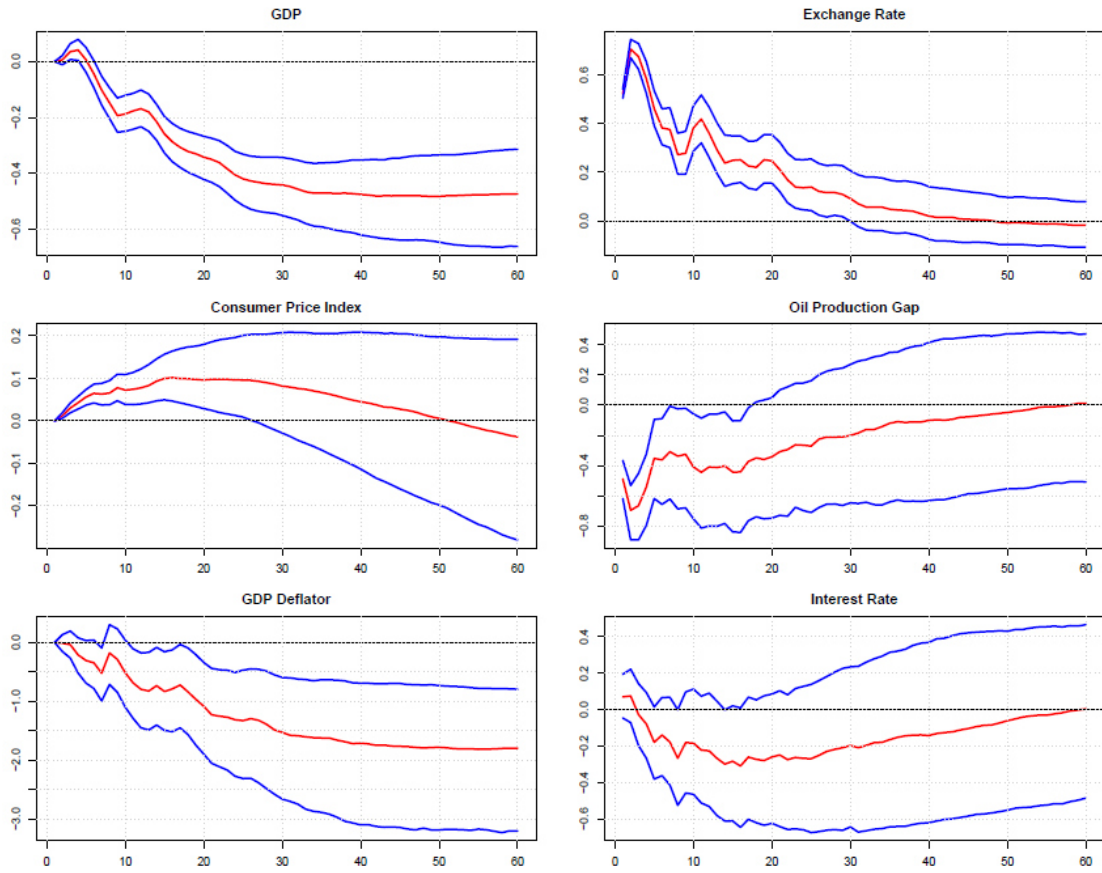


Figure 4.6: Structural Impulse Response to Oil Supply Shock
 Source: Generated by the Author using R-Software 3.6.1(2019)

From the plots of the responses of the key macroeconomic variables, the study can infer about the dynamic response of each of the six-component vector of endogenous variables. The red-line shows the point estimates of the responses while blue-line is error band which is fixed at 68% standard error.

From the top left corner of figure 4.6, the response of real GDP to a one-unit standard deviation increase in the global oil supply indicates that Nigeria’s real GDP reacts negatively with initial shock transmission into the economy. The persistence decline in real GDP continues rather slowly as the time horizon goes deeper into the future. The shape of the impulse response of the real GDP further declines until it approaches zero at the 60th horizon before the impact of the shock dies out of the economy. Empirically, the study can establish

that fall in oil price due to increase in its supply will generate fall in revenue into the economy. This will translate into lower real GDP in Nigeria.

The unrestricted sign attached to real exchange rate shows that the response of the exchange rate to increase in oil supply is persistent depreciation of Nigeria's currency. From the top right corner of figure 4.6, it shows that there is immediate short-lived positive reaction of the Nigeria's currency with increase in the global supply of oil at the international market which gradually becomes negative induced-movement. The persistent depreciation continues until it reaches zero at 20th horizon and becomes negative throughout the shock scenario.

The consumer price index is negative and remains in the region for the entire period of the shock. This behavior of the consumer price index can be explained in terms of high degree of openness nature of the Nigeria's economy. The fall in price resulting from increase in oil supply makes the Nigeria's economy more vulnerable and, therefore, the immediate negative reaction of the consumer price index.

The response of the oil production gap to a one-unit increase in the supply of oil is depicted to be positive. The supply shock in oil widens the oil production gap in the economy as the activities of the Niger-Delta increases. Their disruption of oil production increases as a result of the increase in the supply of oil at the global market.

The response of GDP deflator and real interest rate shows that while the former increases positively to the shock, the latter shows a negative reaction. These responses can be attributed to the fact that the economy is heavily influenced by external shocks (trade and financial shocks).

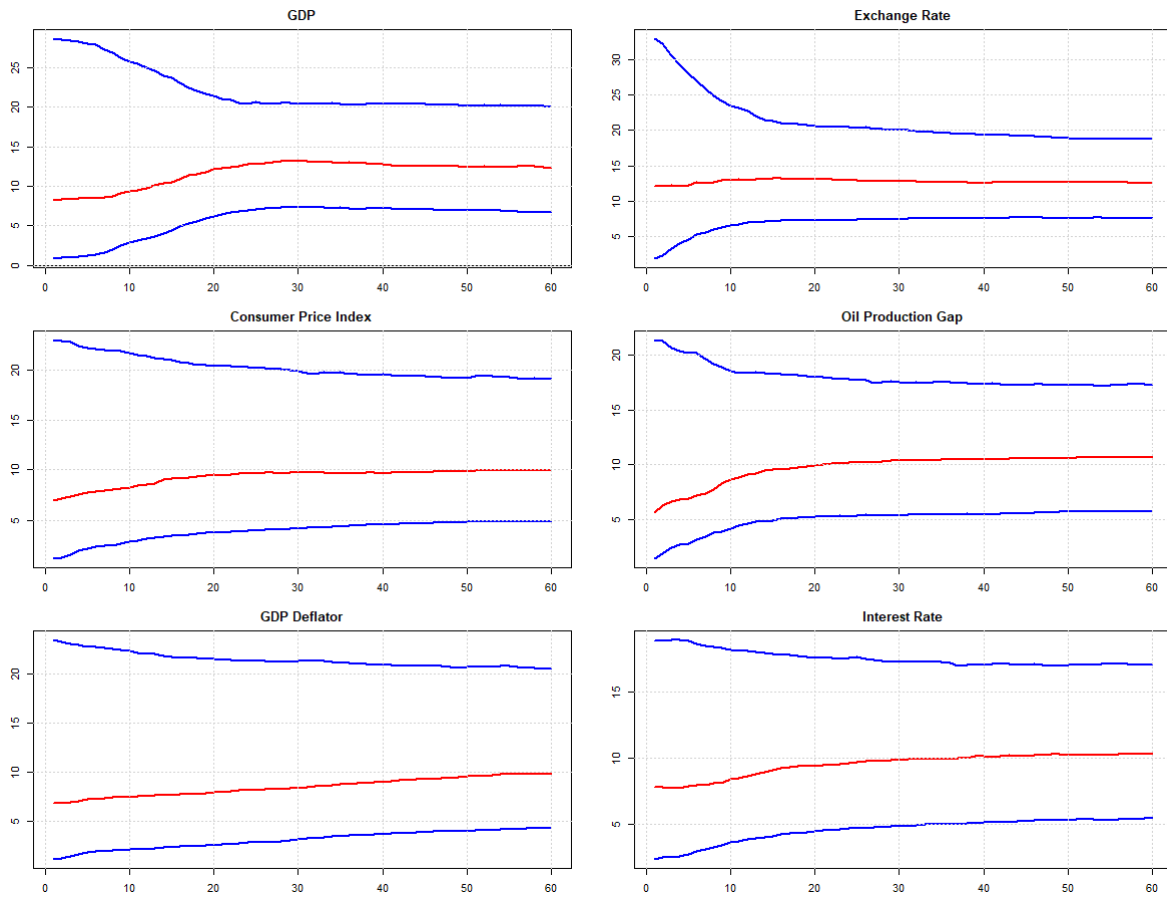


Figure 4.7: Forecast Error Variance Decomposition
Source: Generated by the Author using R-Software 3.6.1(2019)

The figure 4.7 gives the estimates of the forecast error variance decomposition with oil supply shock. We can see that as the time horizons increases into the future, the contribution of the GDP, exchange rate, consumer price index, oil production gap, GDP deflator and interest rate becomes significant in the economy.

Table 4.7: Forecast Error Variance Decomposition

Gap	GDP	GDP Def.	CP Index	IR	Exch Rate	Oil Prod.
1	8.26	6.93	6.83	12.15	5.68	7.78
10	9.31	8.27	7.49	12.98	8.59	8.36
20	12.16	9.49	8.02	13.16	9.92	9.38
30	13.15	9.73	8.43	12.80	10.36	9.83
40	12.81	9.67	9.06	12.60	10.45	10.12
50	12.48	9.85	9.62	12.62	10.55	10.26
60	12.34	9.97	9.86	12.62	10.60	10.3

Source: Computed by the researcher using R-Software version 3.6.1(2019)

From the table, it can be seen that at the initial forecast horizon, the role of interest rate can be strongly felt by the economy (12.15), although marginal, but exact greater influence in the economy. The contribution of the real IR and real GDP remain strong in the economy till the last end of the forecast error. Thus, the table 4.7 reveals that much of the fluctuation of the Nigeria's economy following oil supply shock is traced to the vulnerability of the of the real measure of economic activity, real GDP and real interest rate. Other significant determinant of the macroeconomic fluctuations in Nigeria's, as revealed from the table, is traced to the role of exchange rate in the country. Thus, the study further illustrates the importance of external economy in (dis)stabilizing the economy.

4.3.3 Niger-Delta Militant Activities

In this sub-section, the study aims at achieving the fourth objective; assessing the activities of the Niger-Delta on the oil extraction and production in Nigeria. As the daily oil production in Nigeria is never realized, significantly partly due to the disruption and distortions created by militants in the area. The study intends to quantify the gap in oil production and measure its consequences as a revenue loss to the Nigerian economy.

The conceptual understanding of the study is to measure the difference between the actual oil production level and the potential oil production level and use the gap as a time series data spanning across period of the study. The shortage in oil production represents the information sets (data) which is used as exogenous variable in the model. This shortage is called, in this study, *the oil production gap*. It is simply the difference between the potential and actual level of oil production.

The study uses this variable as exogenous in the model and extracts orthogonal shock from error-covariance matrix and produce figure 10.

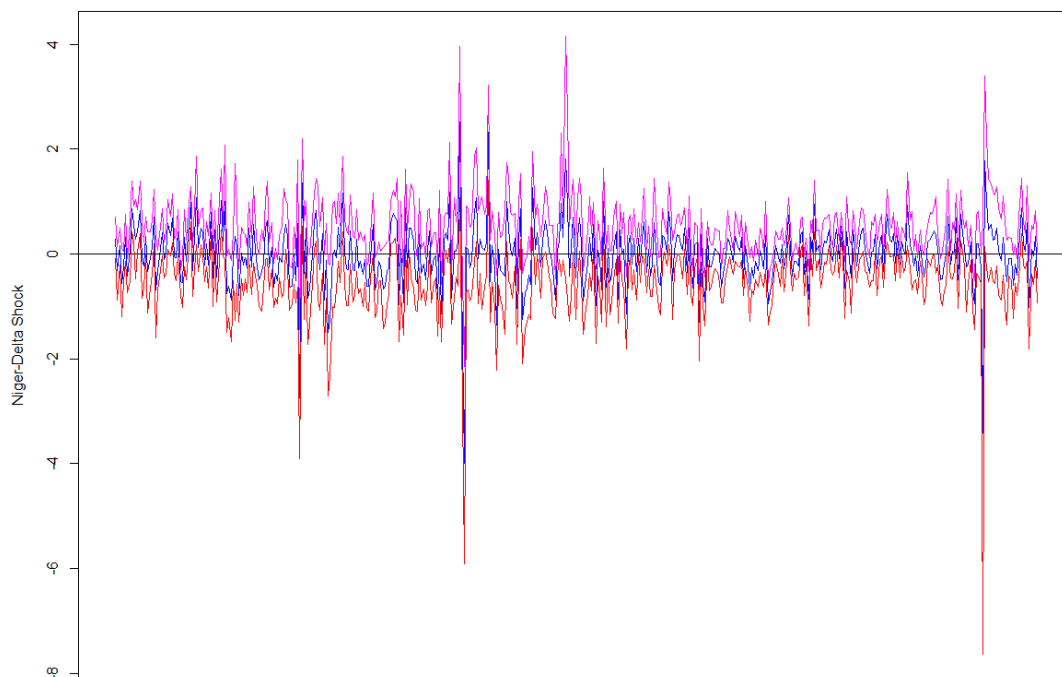


Fig 4.8: Exogenous Shock of Niger-Delta
 Source: Generated by the Author using R-Software 3.6.1(2019)

Inference from the plot in figure 4.8 suggests that the oil production gap is significant in determining the performance of the economy. The series causes significant changes in the oil production and this creates instability in the performance of the economy. Loosely put, the shock coming from disruption of Niger-Delta militants via oil spillage, vandalization, bunkering impact significantly on the oil production, which will affect the revenue in Nigeria. From the figure, volatility in oil production which is induced from oil disruption is erratic and unpredictable, with high tendencies of producing fluctuations in the real GDP of the country. For this, one can say that, based on the evidence in figure 4.8, the activities of the Niger-Delta militants has far reaching negative consequences on the performance of oil sector, it's production level, the revenue generated and subsequently, economic activities in the country. This finding is in line with Oluniyi's (2017) study that posits that Oil losses on account of militancy amounted to over \$1 billion annually, which represents 32% of the revenue the country generated that year. In the same vein, Kackchukwu(2016) found that Militant activities

in the Niger Delta region especially, the emergence of the new emerged group called, Niger Delta Avengers (NDA) had forced supply disruption of oil and gas and had made the country output fall by 800 million barrels per day to 1.4 million barrels per day.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of Findings

The main policy thrust for the empirical investigation presented in the study is oil price, the Nigerian economy and the activities of Niger-Delta militants. The study, has among others, analysed oil price volatility, forecast of the daily oil price for policy adjustment, studied the responses of some selected macronomic variables to oil price crash, and the impact of the exogeneous activities of the Niger-Delta militants. Thus, the study achieved these objectives empirically with data-driven conclusions. The study used five chapters which are interrelated. The first chapter consists of the background to the study which connects the motivation for the study with the statement of the problem, research questions and objectives of the study. Detail discussion on the theoretical framework, empirical evidences, cutting across studies from Nigeria and other economies, and conceptual literature are presented in the second chapter. Model building and it's justification are discussed in chapter three. Measurement and definition of the variables, sources of the data, transformation of the data are sufficiently presented. Findings from the models estimated and discussions of the results are presented in the fourth chapter of the study. The estimates of the models, plots generated and figures are all highlighted in the chapter.

The study unveils interesting facts in several layers. The study is able to establish contribution to knowledge in empirical application as well as methodological gap. We can summarise these contributions constructively in two folds.

In the area of empirical application, the study can report, with high degree of confidence, to the best of our knowledge, that there has not been any study in Nigeria that incorporate noise factor in relation to the Niger-Delta militant activities. The study accomplishes this task intuitively and scientifically by generating a series of oil production gap and build the data

into the structural vector autoregression and uses sign identification scheme and analyze the impact of the exogeneous shock on oil production.

On the issue of methodology, the study can argue, with reasonable justification, that most of the existing studies in Nigeria employ recursive identification, short-run identification and long-run identification as the main dominant of oil price shock identification in structural vector autoregression. It is already established in the literature that recursive identification cannot properly identify oil price shock in structural vector autoregression, and equally, the short-run and long-run identification scheme cannot yield orthogonal shock. So, it is based on these weakness that this study adopts more robust and superior method of shock identification; sign restriction of Arias et'al (2014).

Hence, the major findings include;

- It was found that the daily oil prices are time-specific, where by two regimes were found; regime one is characterized with low volatility levels, low persistence and high reaction to past negative returns, while regime two as “turbulent market conditions” with high volatility levels and strong persistence.
- The study was able to prove that Regime changing GARCH models that is Markov-Switching GARCH model is a more robust model, in that it has the least forecast error, and hence can be more relied upon for forecasting performance of oil price than other traditional models. The Forecast provided by the models used in the study are more appropriate for effective policy recommendations.
- It was established that exogenous shock has impact on oil production via the generated series; Oil Production Gap, and is a resultant of the Niger-Delta activities, causes significant changes in the oil production and this creates instability in the performance of the economy.

- It was yet again, found that recursive, short-run and long-run identification are less robust and hence sign restriction was used to analyze the impact of oil shocks on the performance of the economy. It was found that fall in oil price due to increase in its supply will generate fall in revenue into the economy. It was also found that there is immediate short-lived positive reaction of the Nigeria's currency with increase in the global supply of oil at the international market which gradually becomes negative.

5.2 Conclusions

Decidedly from the results, the conclusions of the study are as follows;

It is established empirically that oil price is characterized with switches in its dynamic behavior. There is rather discrete changes in the prices of oil which substantially different to assume that the oil prices have differing regimes. The low oil price volatility and high oil price volatility are established in the study based on the characteristics of the volatility, coskewness, fat-tails, persistence, varying correlations in the oil price. The study further establishes, empirically, that the volatility of the oil price is time varying. Put loosely, there is strong support from the estimates of the model that volatility in the daily oil price is not fixed, but rather involving and time-specific. This new finding is not so surprising because there are evidences of oil boom (high prices) and oil slump (low prices). In these two different episodes, the mean, variance and covariances of the oil series are not only expected to be different, but it is also expected to be time varying.

In the second fold, the study concludes that forecast performance of oil price is optimally maximized when the model incorporates flexible features such as regime shifts, non-normal distributions such as skewed student t distribution in the variance term. The study estimates and compares two class of volatility models and, on the basis of some statistical criterion, select the best performing model of forecasting oil price. Forecast provides useful tools for policy prescription and diagnosis. In sum, for a country like Nigeria that is oil-dependent,

forecast of oil with wide margin of error can lead to substantially bias with negative consequences for policy formulation.

Another conclusion reached from the study is that oil price shock is key in explaining fluctuations in macroeconomic variables in Nigeria. The volatility in oil revenue leads to volatility in fiscal spending by government and subsequently creating deficit in government's ability to provide its fiscal responsibility. Oil shocks from demand side, supply side and other specific shocks that's demand-driven are established to have impacted on the economy of the country. Thus, the study reaffirms the role of oil in influencing the Nigerian economy.

It is also concluded that oil production gap, which is caused as a results Niger-Delta militants activities, is established to have negative impact on the performance of the economy. Revenue loss due to realized gap, caused by bunkering, spillage, burning and disruptive activities, drives off substantial gain to the economy. Therefore, activities of the Niger-Delta is disastrous and negative consequences in the economy. It is also established that, from the empirics in the study, exogeneous shock of Niger-Delta creates big-uncertainty in the economy.

5.3 Recommendation

The recommendations are linked to the findings of the study. Thus, they are discussed in line with the research questions raised and data-driven evidences.

Firstly, the study recommends that policy relating to analysis of volatility of oil price be revisited by researchers and policy makers, because of the wide margin of error inherent in the earlier empirical investigations in Nigeria. Forecasts produced from volatility models that fails to account for discrete changes in the amount of volatility are likely to mislead the policy makers in terms of approximating the actual prediction of oil prices. This can cause significant imbalance in the economy as it relies heavily on the proceeds of oil revenue

Secondly, the economy needs to extend to establish external policies to thwart the impact of external sector on the currency and the economy in entirety. This can be done by observing and analyzing the behavior of the global oil market and predicting its negative effects accordingly, hence take action against it in good time. This is evident from the initial positive response of exchange rate with oil demand shock and then reacts negatively, which will further plunge into depreciation of the country's currency. Consequently, consumer price index consistently and persistently falls. This scenario underscores the importance and dominance of external sector in dynamic interaction of the macroeconomic variables in Nigeria.

Thirdly, external absorbers and automatic built-in stabilizers must be put in place to serve as a mechanism for correcting disequilibrium in oil revenue. This is recommended by the study as it is able to evident significant influence of both demand and supply shock of oil price on the stability of economic growth in Nigeria. Therefore, the policy makers must recognize the role of effective mechanism of absorbing the shock from oil price movement so that the baseline growth will not deviate significantly.

Fourthly, it is strongly recommended that the government must find lasting solution to the activities of the Niger-Delta militants. It is established from the analysis that the activities of these militants create serious lost of revenue to the economy. For more than decades, Nigeria has not been able to meet up the qouta allocated to the country, which partly, can be traced to the activities of the militants. Thus, it is suggestive that the central government to create some dialogue between the community leaders, the militants and the government officials.

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APPENDIX

Two-Regime Markov Switching GARCH

Specification type: Markov-switching

Specification name: gjrGARCH_stdgjrGARCH_std

Number of parameters in each variance model: 4 4

Number of parameters in each distribution: 1 1

Fixed parameters:

None

Across regime constrained parameters:

nu

Fitted parameters:

	Estimate	Std. Error	t value	Pr(> t)
alpha0_1	0.2071	0.0488	4.2432	1.102e-05
alpha1_1	0.0005	0.0088	0.0569	4.773e-01
alpha2_1	0.2137	0.0619	3.4505	2.798e-04
beta_1	0.5264	0.0995	5.2921	6.045e-08
nu_1	9.2468	1.3292	6.9569	1.739e-12
alpha0_2	0.0922	0.0349	2.6397	4.149e-03
alpha1_2	0.0052	0.0169	0.3050	3.802e-01
alpha2_2	0.1516	0.0381	3.9771	3.488e-05
beta_2	0.8716	0.0354	24.6380	<1e-16
P_1_1	0.9977	0.0014	701.8429	<1e-16
P_2_1	0.0027	0.0017	1.6006	5.473e-02

Transition matrix:

	t+1 k=1	t+1 k=2
t k=1	0.9977	0.0023
t k=2	0.0027	0.9973

Stable probabilities:

State 1	State 2
0.5407	0.4593

LL: -3350.8467

AIC: 6723.6934

BIC: 6787.7579

Researcher's computation

Single-Regime Exponential GARCH (E-GARCH)

Specification type: Single-regime

Specification name: eGARCH_norm

Number of parameters in variance model: 4

Number of parameters in distribution: 0

Fitted parameters:

	Estimate	Std. Error	t value	Pr(> t)
alpha0_1	0.0090	0.0045	1.9973	2.289e-02
alpha1_1	0.1893	0.0375	5.0479	2.234e-07
alpha2_1	-0.0984	0.0173	-5.6853	6.528e-09
beta_1	0.9243	0.0189	48.8532	<1e-16

LL: -3459.7876

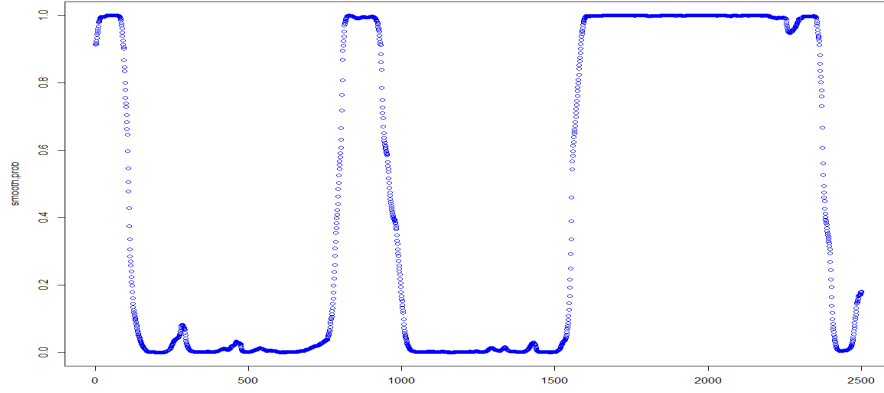
AIC: 6927.5751

BIC: 6950.8713

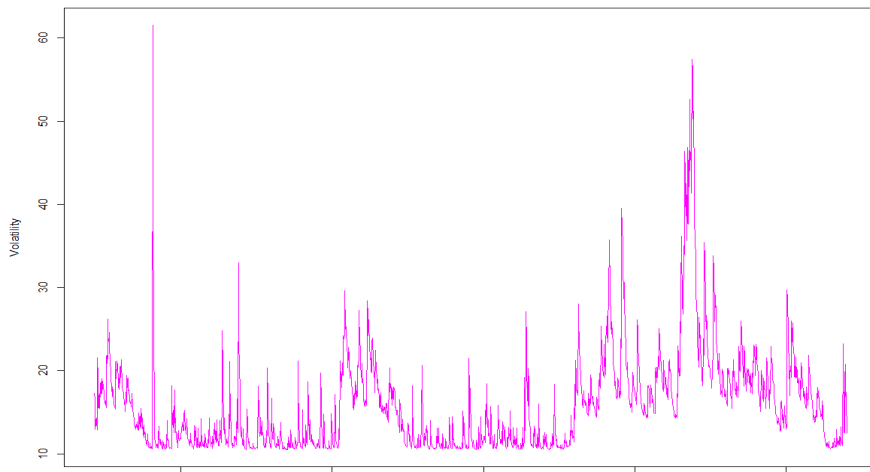
Forecast Performance of the Models: Volatility Forecast

Forecast horizon	MSGARCH-n	E-GARCH-n	MSGARCH-t	E-GARCH-t	MSGARCH-sn	E-GARCH-sn
h=1	2.3919	5.9151	2.4428	9.0442	2.4844	10.3011
h=2	2.3221	10.4429	2.4682	8.3254	2.3703	5.9101
h=3	2.3640	4.9963	2.4370	7.8273	2.4624	6.5382
h=4	2.3724	6.6105	2.3427	5.1898	2.4524	6.2482
h=5	2.3833	9.5005	2.4633	9.9616	2.3912	4.5601
h=6	2.3516	6.3168	2.4368	9.2008	2.4162	6.6870
h=7	2.4018	10.1831	2.4169	5.4013	2.4443	7.1864
h=8	2.4169	9.5506	2.3256	6.4852	2.3005	7.7151
h=9	2.3515	10.4554	2.3573	9.6132	2.3514	6.1141
h=10	2.3501	6.8069	2.3763	10.4975	2.3932	6.7378
h=11	2.3971	5.3034	2.3499	9.1142	2.3929	4.9510
h=12	2.4465	6.5394	2.4982	5.4406	2.4617	5.1248

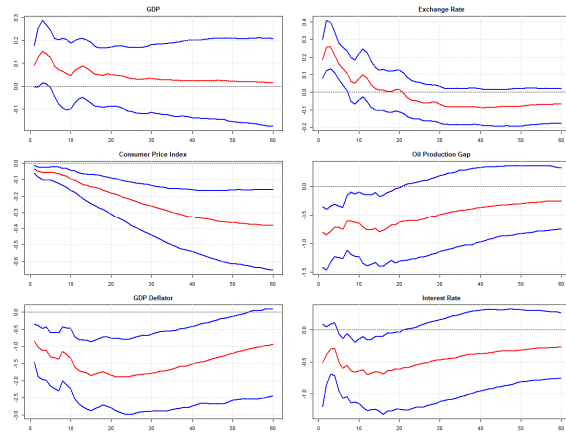
Smoothed Probability from MS-GARCH model



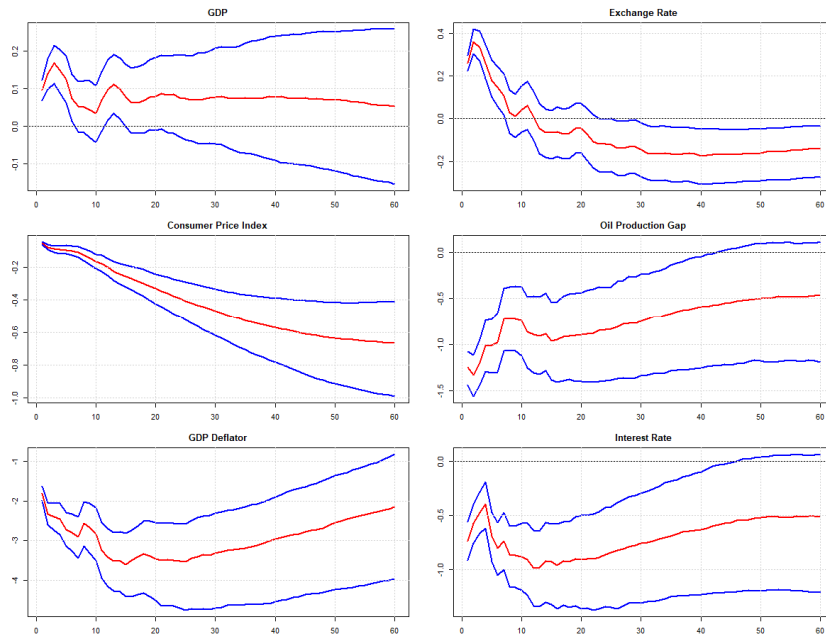
Volatility Estimates from MS-GARCH Structural Impulse Response to Oil Supply Shock
 Conditional volatility



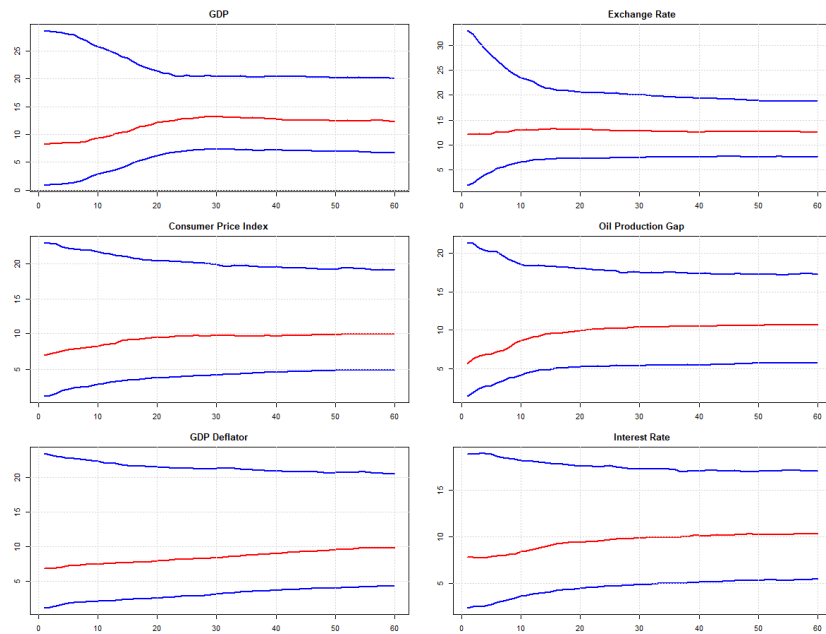
Structural Impulse Response to Oil Supply Shock



Structural Impulse Response to Oil Demand Shock



Forecast Error Variance Decomposition



Forecast Error Variance Decomposition

	<i>GDP</i>	<i>GDP Def.</i>	<i>CP Index</i>	<i>IR</i>	<i>Exch Rate</i>	<i>Oil Prod.</i>	<i>Gap</i>
1	8.26		6.93	6.83	12.15	5.68	7.78
10	9.31		8.27	7.49	12.98	8.59	8.36
20	12.16		9.49	8.02	13.16	9.92	9.38
30	13.15		9.73	8.43	12.80	10.36	9.83
40	12.81	9.67	9.06	12.60	10.45	10.12	
50	12.48	9.85	9.62	12.62	10.55	10.26	
60	12.34	9.97		9.86	12.62		
10.60		10.3					

Exogenous Shock of Niger-Delta

