ANALYSING THE IMPACT OF CRUDE OIL PRICE VOLATILITY ON MONETARY POLICY IN NIGERIA

BY

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BEING A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTERS OF SCIENCE DEGREE IN ECONOMICS

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DECLARATION

I Okomayin Celestina Glory Ofuje with registration number M.SC/SOC-SCIE/12396 /2007-2008 do solemnly declare that this work 'Analyzing the Impact of Crude Oil Price Volatility on Monetary Policy in Nigeria: 1980-2010' was undertaken by me and to the best of my knowledge, the work has not been presented anywhere for the award of any degree. All sources of information and materials used for the study were fully acknowledged in the reference

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CERTIFICATION

This is to certify that the thesis work titled 'Analyzing the Impact of Crude Oil Price Volatility on Monetary Policy in Nigeria:1980-2010' conducted by Okomayin Celestina Glory Ofuje (M.SC/SOC-SCI/12396 /2007-2008) meet the requirement for the award of Master of Science Degree in Economics, in the postgraduate school, Hamada Bello University, Zaria. The work is this day approved for its contribution to knowledge and literally presentation.

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DEDICATION

To God Almighty and to my beloved Husband Clifford Ife Ajayi.

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ABSTRACT

The study analyzed the impact of crude oil price volatility on monetary policy in Nigeria for the period 1980:1 to 2010:4. The study was undertaken with two main objectives. The first objective was to estimate the extent of crude oil price volatility. And secondly, to analyze the impact of crude oil price volatility on monetary policy in Nigeria. The study used quarterly secondary data and ARCH and GARCH method to analyze the data. The results of the study shows that crude oil prices are volatile and that crude oil price volatility have significant negative impact on monetary policy, net foreign assets and crude oil export in Nigeria. However, the impact of crude oil price volatility on crude oil import was insignificantly negative. The sum of ARCH and GARCH coefficients in the money supply, net foreign asset, and crude oil export models showed that volatility is persistent (i.e. the error terms have infinite variance) while it was not persistent in the crude oil import model. This suggests that crude oil price volatility has been part of the reasons for the distortions or instability in monetary policy, net foreign asset, and crude oil export in Nigeria. Furthermore, there is ample evidence that real output, inflation and interest rates exerted significant impact on monetary policy in Nigeria. Therefore, the current surge in crude oil prices has the potentials of affecting monetary policy performance in Nigeria.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The Nigerian economy depends heavily on export of crude oil as the major source of Government revenue and export. The Nigerian oil sector accounts for over 95 percent of export earnings and about 85 percent of Government revenues, (Aliyu, 2009). Crude oil production and export play a dominant role in the Nigerian economy and account for about 90 % of her gross earnings. This dominant role has pushed agriculture, the traditional mainstay of the economy, from the early fifties and sixties, to the background (Odularu, 2007).

Oil prices and oil revenues are volatile and it makes the economy vulnerable to external shocks. Falling oil prices can put serious strains on Nigerian fiscal balances or on their ability to borrow from abroad while rising oil prices can be accommodated by economy (Kilian, 2009). Some of the additional revenues as a result of rising oil price are used to finance imports of refined petroleum products and the balance is shared among the three tiers of Government from the excess crude oil account.

Crude oil price volatility has significant implication for stability of fiscal and monetary policies and the entire Nigeria economy because expenditures are not smoothening in anticipation of future decline in the real price of oil when there is a boom. It is also good to know that the extra revenue is not used to diversify the domestic economy. As a result, the ability of the domestic economy to absolve infusions of capital from excess crude account is limited hence the need for monetary policy (Kilian, 2009).

Oil price shocks have large and potentially harmful effects on external accounts (both for net oil importers and exporters), forcing countries to deplete their reserves and sometimes

borrow from abroad to offset adverse terms-of-trade shocks and leading to the crowding-out of the tradable sector by means of exchange rate appreciation (Dutch disease) for net oil exporters, (Chuku, 2010).

The monetization of oil revenue has been a major problem in liquidity management in Nigeria. Measuring liquidity as the narrow and broad money definitions by the CBN, which is responsible for keeping liquidity in check so that the three key macroeconomic prices (interest rate, exchange rate and inflation rate) are not affected thereby creating market distortions and inflationary pressure (Biodun, 2004).

An excessive deficit fiscal operation which accompanies increase in oil revenue makes Government to engage in frivolous spending on unnecessary projects. Deficit spending invariably makes Government resort to borrowing from the Central Bank through the instrument of Ways and Means Advances, which later is converted into short term debt instruments that are quite expensive to service at market rates (Odularu, 2007).

The achievement of a balance is paramount in the design of monetary policy as an excess or shortage in the supply of money could either induce excessive aggregate demand, resulting in higher inflation rate or induce stagnation, thus retarding economic growth and development.

1.2 Statement of the Problem

Since 1970, the Nigeria Government has been overly dependent on the oil sector as the most important source of revenue accounting for about four-fifth of the total Government revenue. In the recent past decades, the global energy market has witnessed several shocks in oil prices. (Chuku etal, 2010).

These shocks usually come as a two-edged sword, offering enormous opportunities in terms of profits and revenue for oil exporting economies like Nigeria, and at the same time,

ushering in several political-economy challenges, including distortions in macroeconomic dynamics. Particularly, oil price shocks have a strong potential to affect a major macroeconomic variable in an oil exporting country, namely the current account. Oil price shocks primarily affect the current account of a country by distorting the savings-investment identity (Chuku etal, 2010).

The problem of excess liquidity arising from the expansionary fiscal operations during booms and the rapid monetization of crude oil receipts also makes it difficult to scale down expenditure whenever there is a significant deterioration in the price of crude in the international oil market (Babalola, 2009). Oil price changes also influence foreign exchange markets and generate stock exchange panics, higher interest rate produce inflation and eventually lead to monetary and financial instability (Aliyu, 2009).

Despite the general recognition that oil plays an important role in the Nigerian economy, less attention has been given to the impact of oil price volatility on monetary policy. However, an economic theory (open economy macro economy) indicates that the effect of oil price volatility on monetary policy is critical to the effects of oil price volatility in the economy. Empirical analysis of the oil price – monetary policy nexus is therefore a useful exercise. To better estimate the effects, the following questions are relevant.

i. What is the degree and pattern of crude oil price volatility?
ii. To what extent does crude oil price volatility affect monetary policy?

1.3 Objective of the Study

This study has the broad objective of estimating the impacts of crude oil price volatility on monetary policy. Specifically, the study seeks to achieve the following,

i. To estimate the extent of crude oil price volatility.
ii. To analyze the impact of crude oil price volatility on monetary policy in Nigeria.

iii. To deduce policy implications of the results.

1.4 Justification of the Study

Estimating the impacts of oil price volatility on monetary policy is particularly relevant in the case of Nigeria since, as a small open economy, it has no real influence on the world price of oil, whereas it is greatly influenced by the effect of oil price volatility both as an oil exporter and importer of refined petroleum products. For commodity importing and exporting nations, an understanding of the risks associated with price volatility can allow better targeted policy. At the microeconomic level, the stochastic behavior of prices is relevant to evaluating real investments using modern asset pricing techniques. The relative volatility of various commodities is also a factor in evaluating descriptive models of energy conservation behavior.

1.5 Scope and Limitation of the Study

The period covered by this research is from 1980 to 2010. The period covers periods of boom and burst. It also covers periods of two monetary policy regimes: periods of direct monetary policy (1980 – 1985) and indirect controls (1986 – 2010).

1.6 Organization of the Study

The study is divided into five chapters. Immediately after the general introduction, chapter two highlights the literature review and this consists of conceptual literatures, an overview of monetary policy in Nigeria, theoretical literatures and review of the empirical literatures on the link between oil price and monetary policy. Chapter three presented the research methodology while Chapter four covers the presentation, analysis and interpretation of results and summary of major findings. Chapter five, the concluding chapter presented the summary, conclusion and recommendations of the research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Literature

2.1.1 Concepts in Monetary Policy and Volatilities of Crude Oil Prices

Monetary policy is a blend of measures and or set of instruments designed by the Central Bank to regulate value, supply and cost of money consistent with the absorptive capacity of the economy or the expected level of economic activity without necessarily generating undue pressure on domestic prices and the exchange rate (Okafor, 2009). According to the United States Federal Reserve Board, (2006), monetary policy is the process by which the Government, Monetary Authority or Central Bank of a country controls the supply of money, availability of money and cost of money or interest rate to attain a set of objectives oriented towards the growth and stability of the economy. Also, according to the CBN, (2009), monetary policy refers to specific action taken by the Central Bank to regulate the value, supply and cost of money in the economy with a view to achieving Government's macroeconomic objectives.

Therefore, the ultimate goal of monetary policy is to ensure the achievement of a consistency between the expansion in domestic liquidity and Government's macroeconomic objectives of price and exchange rate stability, higher output growth, full employment of resources, balance of payment equilibrium, promotion of sound financial system and sustainable growth and development (Okafor, 2009). In some countries, monetary policy objectives are explicitly stated in the law establishing the Central Bank, while for others they are not. The objectives of monetary policies may vary from country to country but there are two main objectives which are to achieve price stability and other macroeconomic objectives. In Nigeria however, the objectives of monetary policy include: maintenance of price stability, attainment of

full employment, maintenance of balance of payments equilibrium, exchange rate stability and promotion of a steady and sustained level of economic growth (CBN, 2009).

According to Okafor, (2009), low and stable inflation has become the core mandate for most Central Banks across the globe for the obvious reason that inflation has cost on the economy. These cost include macroeconomic costs in which producers may mistake a general price increase for a relative price increase and may undertake unwarranted expansion of capacity, while and savers may not know the real rate of interest, distributional cost in which borrowers gain at the expense of savers and resource costs in which economic agents commit resources that could have been more efficiently and beneficially utilized, to protect themselves against the effects of inflation.

Monetary Policy Instruments and Process

Monetary policy instruments are tools which the Central Bank uses to conduct and implement monetary policy. According to Oke, (1995), the direct instruments of monetary policy were, sectoral credit allocation, credit ceilings and reserve requirements, administrative fixing of interest and exchange rates, special deposits and moral suasion. The indirect instruments are open market operations, reserve requirements, discount window operations and moral suasion. However, monetary policy management refers to an aspect of macroeconomic management which is undertaken by the CBN on behalf of the Federal Government. The monetary policy process is a fairly complex procedure involving objectives and target setting, monetary programming, choice of nominal anchor, policy instruments and the institutional framework of monetary policy implementation as well as communication and evaluation of outcomes (Uchendu, 2009).

Objectives and Targets of Monetary Policy

In Nigeria, the major objectives of monetary policy are the attainment of price stability and sustainable economic growth (Uchendu, 2009). Associated objectives are full employment and stable long term interest rates. In pursuing these objectives, the CBN recognizes the existence of conflicts among objectives necessitating at some point some sort of trade-offs. The targets of monetary policy in case of CBN are the operational targets, the intermediate targets and the ultimate targets. The bank manipulates the operating target (reserve money) over which it has substantial control to influence the intermediate target (broad money supply,M2) which in turn impacts on the ultimate or final objective of monetary policy, that is, inflation and output (Uchendu, 2009). The broad money supply comprises of narrow money (M1) and quasi money while the operating targets, reserve money is made up of currency in circulation and bank deposits with the Central Bank.

Nominal Anchor of Monetary Policy

A nominal anchor for monetary policy is a single variable or device which the Central Bank uses to pin down expectations of private agents about the nominal price level or its path or about what the bank might do with respect to achieving that path (Krugman, 2003). Generally, there are two types of nominal anchor: quantity based and priced based. The quantity based nominal anchor targets money while the priced based targets exchange rate or interest rate (Uchendu, 2009). It is important to note that exchange rate targeting may not produce the desired result if the interest rate is also subject to control at the same time. Some rules are necessary for effective monetary policy; in this case, prices such as interest rate and exchange rate may not be controlled or pegged at the same time. If interest rate is controlled, the exchange rate should be

allowed to move freely for the necessary adjustment to materialize so that price stability could be attained.

2.1.2 Shocks and Crude Oil Price Volatility

Shocks to the system could be endogenous or exogenous shocks. Endogenous shocks refer to unexpected economic events which originate independently from within a system and which may take the economy off course (Riley, 2006). However, exogenous shocks refer to unexpected economic events which originate independently from outside a system and which may have the effect of driving the economy off course. Exogenous shocks have two types; Demand side shocks and Supply-side shocks.

- **Demand side shocks:** Demand side shocks refer to shocks affecting the rate of growth of demand both in Nigeria and other countries. Demand-side shocks include a capital investment boom e.g. a construction boom or rapid growth of spending on ICT, a pre-election Government spending, a sudden and significant rise or fall in the exchange rate – affecting net export demand and having follow-on effects on output, employment, incomes and profits of businesses linked to export industries (Riley, 2006).
- **Supply-side shocks:** Supply-side shocks refer to shocks affecting costs and prices in different countries of the world (Riley, 2006). Supply-side shocks to the economy could be oil prices fluctuations, and the emergence, adoption and take-up of a new production technology arising from invention and innovation that has the effect of reducing cost for producers and prices for consumers.

Therefore, the term oil price shock denotes an unpredictable change in the real price of oil, on a month-to-month basis (Kilian, 2010). It is also used to refer to episodes of large cumulative changes in the real price of oil, often extending over several years. An oil price shock

in the latter sense need not involve any large unpredictable changes. It may be driven entirely by many small unpredictable changes in real price of oil in the same direction (Kilian, 2010).

The Oxford Advance Learners' Dictionary definition of volatility is given as the statistical measure of the dispersion of returns for a given security or market index. Volatility can be measured by using the standard deviation on variance between returns from that same security or market index.

Measure of Crude Oil Price Volatility and Shocks

It is worthwhile studying the volatility of oil prices, because volatility measures the uncertainty in the oil prices. The higher the volatility, the greater is the uncertainty facing the market. The most obvious indicator of an oil price shock is the nominal oil price. In an early article, Hamilton (1983) shows that increase in the nominal price of oil granger-causes downturn in economic activity. However, more recent study have shown this simple measure to have a rather unstable relationship with macroeconomic outcomes, leading subsequent researchers to employ increasingly complicated specifications of the "true" relationship between oil and the economy.

Hamilton (1996) argued that the correct measure of oil shocks depends on how the price of oil affects the economy and he proposed a more complicated measure of oil price (CP) changes: the "net oil price increase". The measure distinguishes between oil price increases that establish new highs relative to recent experience and increases that simply reverse recent decreases. For quarterly data, the "net oil price increase" compares the price of oil in each quarter with the maximum value observed during the preceding four quarters. If the value for the current quarter exceeds the previous year's maximum, the percentage change (say 10%) over the previous year's maximum is plotted (i.e. CP = 0.1). If the price of oil in quarter t is lower than it

had been at some point during the previous four quarters, the series is defined to be zero for date t (CP = 0).

In addition to Hamilton's "net oil price" measure, the energy economics literature provides many alternative indicators of oil price shocks. Those proposed by Federer (1996) and Lee, Ni, and Ratti (1995) for example, focus on the volatility of oil prices. Mork (1989) proposed an asymmetric relation in which the regressor is given by the magnitude of the oil price change when oil prices increase but equal to zero when oil prices decrease. Therefore, the operational measure of volatility for this study is discussed in chapter three.

The implication of volatile prices in the global market and in particular, the current rising oil prices in the international market is analyzed at this section. The most possible impact of this oil price shock on the global economy is inflationary pressure. The macroeconomic implications of rising oil prices depend on several factors;

- Whether a country is a net importer or exporter of oil. Nigeria is still a net exporter of crude oil (though we import a lot too!). According to Mussa, (2002), there will be a transfer of income from oil consumers to oil producers; as the propensity to spend of those who lose income (energy consumers) is generally larger than the propensity to spend of those who gain income (energy producers). This will cause some fall in demand. On an international level, the transfer is from oil importing countries to oil exporters and oil exporters tend to expand demand only gradually.
- The scale of oil dependency of an economy i.e. the ratio of oil used per unit of national output produced. Some countries have a reliance on high-energy using industries and are therefore more susceptible to changing oil and commodity prices. Others have a much

smaller manufacturing base and national output is dominated by industries that are less energy intensive (Riley, 2006).

- The extent to which rising oil prices are temporary (i.e. lasting only a few months before falling back) or regarded as more permanent (e.g. a period of 3-4 years of high prices). In general, the impact of higher oil prices will be larger than the longer the price rise lasts (Riley, 2006). The possibility exists of "super-spikes" in oil prices, short but sharp movements in prices driven higher or lower by speculative buying and selling in the market.
- The extent to which oil users (consumers) can switch their demand away from oil towards alternative energy substitutes. In the short term, demand is said to be inelastic (Riley, 2006).
- The extent to which the labour market is flexible (in particular the flexibility of real wages) and the ways in which businesses react to higher oil costs.
- The effects of exchange rate changes arising from oil price movements e.g. the naira might rise against the US dollar which could absorb some of the effects of higher oil prices on the Nigerian economy (Riley, 2006).
- The macro-economic policy response to rising oil prices from Central Banks (e.g. changes in monetary policy) and the Government (e.g. changes in fiscal policy).
- Membership of oil producing organization such as OPEC.

2.2 Review of Theoretical Literatures

2.2.1 Theories of Crude Oil Pricing

The Market Base Theory of Crude Oil Pricing

There is a lot of debate surrounding the pricing of crude oil all over the world among scholars, policy makers, organizations and Governments. The central aim of pricing crude oil was to maximize the gains or benefits of the oil industry. Some group of thinkers argued that crude oil needs to be subsidized by the Government so that consumers of the product will pay less in a country producing it. Others are of the opinion that Government should deregulate the sector to maximize the benefits. Still others argued that deregulation of the oil sector have costs implications for the manufacturing sector and the citizens (Olowononi, 2008).

Therefore, the market based theory maintained that crude oil price should be determined by the forces of demand and supply. That is the price of crude oil like any other normal commodity should be determine by the price system. According to Olowononi, (2008), in many oil producing countries, pricing of crude oil has been base on the principle of opportunity cost, which is the world price determine by the forces of demand and supply. The domestic price is determined as border price less freight and other related charges. This theory has the advantage of eliminating arbitrage opportunities engendered by lower domestic price relative to international price. However, the theory is criticized for encouraging smuggling activities and places responsibility on Government by way of subsidy to the product. This result to high consumption and low investment in the domestic economy.

Exhaustive Resource Theory

According to this theory, the price of crude oil may not be consistent with the equilibrium forces of demand and supply as implied by the market based theory, but crude oil as a natural

resource, can be exhausted over time (Hostelling (1931) as in Olowononi, 1999). This theory recognizes the temporariness of crude oil availability so that the price of crude oil is seen as a used costs or depletion charge which compensates for the future generations because they are denied access to the commodity.

Capital Replacement Theory

This theory considered the cost of replacing capital in crude oil production. That is the process of pricing crude oil products should be done in such a manner that will recover the capital expended in its production and refining. This means that the revenue generated from the sales of crude oil and its related products should be greater than the cost of producing them.

The Dutch Disease Theory

Economists W. Max Corden and J. Peter Neary developed the classic economic model describing Dutch disease in 1982. In the model, there is the non-traded good sector (this includes services and two traded good sectors: the booming sector and the lagging sector, also called the non-booming tradable sector). The booming sector is in this case the oil sector. The lagging sector generally refers to manufacturing sector. A resource boom will affect this economy in two ways: resource movement effect and spending effect. In the resource movement effect, the resource boom will increase the demand for labour, which will cause production to shift toward the booming sector, away from the lagging sector. Such an effect can be negligible, however, since the hydrocarbon and mineral sectors generally employ few people.

The spending effect occurs as a result of the extra revenue brought in by the resource boom. It increases the demand for labour in the non-tradable sector, shifting labour away from the lagging sector. This shift from the lagging sector to the non-tradable sector is called indirect

deindustrialization. As a result of the increased demand for non-traded goods, the price of these goods will increase. Prices in the traded good sector are set internationally, so they cannot change. There is an increase of the real exchange rate, an appreciation of the real exchange rate may shrink manufacturing exports and reduce investment from firms, since firms will not invest if they are not sure what the future economic conditions will be. There are also many other harmful effects often associated with Dutch disease, such as corruption and protectionist policies for affected lagging sector industries. Hence the government may not be able to carry out effective and sound macroeconomic, social and industrial policies (Olomola, 2007).

2.2.2 Theories of Monetary Policy

Quantity Theory of Money

According Irving Fisher a proportional direct relationship exist between changes in money supply and the general price level and inversely related to the value of money (what money can buy in real terms). That is to say that the circulation of money stock in the economy is related to the amount of money expended in the economy during a given period of time. The quantity theory of money is based on the link between the stock of money (M) and the market value of output that it finances (PY), where p is the price level and Y is the output. M is related to P with a factor of proportionality k. The relationship is given by;

$$M = kPY \quad \text{..... (2.1)}$$

$$M/P = kY \quad \text{..... (2.2)}$$

k is assumed to be constant Equation (2) can be written as

$$MV = PY \quad \text{..... (2.3)}$$

where $v = 1/k$ and this is the income velocity of money, the ratio of money income (nominal GDP) to money stock or the number of times the stock of money turns over in a given

period in financing the flow of nominal income. Thus V is a useful concept in policy making. Equation (2.3) can be written in growth form;

$$\Delta M = \Delta P + \Delta Y - \Delta V \quad \text{..... (2.4)}$$

If V is constant, then $\Delta V = 0$ so that (2.4) yields

$$\Delta M = \Delta P + \Delta Y \quad \text{..... (2.5)}$$

This is the fulcrum of monetary targeting operated by Central Bank of Nigeria. The operating target, base money is set base on the relationship between money supply and base money and on the assumption of a stable money multiplier. k is illustrated in equation (6).

$$M_2 = kBM \quad \text{..... (2.6)}$$

Where M_2 is broad money supply, k is the money multiplier and BM is base money.

The Keynesian Theory of Money

In his general theory, John M. Keynes faulted the classical and the neo classical economists for keeping separate monetary theory and value theory. He then developed a reformulated quantity theory of money that brought about transition from monetary theory of prices to a monetary theory of output, (Jhingan, 2002). According to Keynes, an increase in money supply may lead to an unacceptable increase in the price level. That is an action by the monetary authority to lower inflation through contractionary monetary policy may cause unemployment in the economy. The theory is based on the following assumptions (Jhingan, 2002). 1) All factor inputs are in perfect elastic supply as long as there is any unemployment. 2) All unemployed factors are homogeneous, perfectly divisible and interchangeable. 3) Effective demand and quantity of money changes in the same proportion so long as there are any unemployed resources. 4) There are constant returns to scale so that prices do not rise or fall as output increases.

Since the supply curve of factors of production is perfectly elastic in a situation of unemployment, wage and non wage factors are available at constant rate of remuneration. As such, prices do not rise with increase in output so long as there is any unemployment. Under circumstance, output, and employment will increase in the same proportion as the quantity of money. But once full employment is reached, output cease to respond at all to changes in the supply of money and so is effective demand. Prices will rise only when the level of full employment is attained and not before it (Jhingan, 2002).

The *Monetarist Theory of Money*

Milton Friedman reaffirmed the position of the neo-classical economists in his articles, 'the quantity theory of money: a restatement' in 1956. He challenged the Keynesian view that money supply does not matter. According to Friedman, inflation is always and everywhere a monetary phenomenon that arises from rapid expansion of quantity of money than in total output. Those changes in the quantity of money will work through to cause changes in nominal income. When money supply is increased, it will increase the demand for goods and services and then lead to increases in price level or nominal income or both.

$$\mathbf{Md = M/P = f\,(Y, R_m, R_b, R_e, R_p, w, u\,)} \quad \text{.....(2.7)}$$

Where; **M** = nominal broad money supply, **P** = the price level, **Y** = real income, $\mathbf{R_m}$ = expected nominal rate of return on money, $\mathbf{R_b}$ = expected nominal rate of return on bonds, $\mathbf{R_e}$ = expected nominal rate of return on equities, $\mathbf{R_p} = (1/P)(\delta P/\delta t)$ = expected rate of change of price of goods and hence the expected nominal rate of returns on physical assets, **w** = fraction of wealth in non human form and **u** = variables other than income that may affect the utility attached to the services of money. He regarded the amount of real cash balances (M/P) as a commodity which is demanded for because it yield services to the person who hold it (i.e. money is seen as an asset or

capital good). The demand for money function is homogeneous of degree one and is therefore stable in the long run when $\mathbf{R_m}$, $\mathbf{R_b}$, $\mathbf{R_e}$, **w**, and **u** are held constant. A rise in expected yield on different assets reduces the amount of money demanded by wealth holder and that an increase in wealth raises the demand for money (Mishkin, 1995). This means that the amount of money which people want to hold in cash or bank deposits is related in a fixed way to their permanent income (which is the expected yield on wealth during its life time). The diagram below explains the theory.

Financial Programming Framework

Financial programming is a comprehensive and consistent set of policy measures aimed at achieving certain desired economic objectives in a given time horizon (Ohuche, 2003). Economic targets and policy measures are set for a period of one to three years ahead. They are specified in concrete, mostly quantitative terms but remain subject to periodic review. The CBN has used the financial programming framework for credit targeting, (Garba, 2003). The Financial Programming Framework (FPF) initially encompasses three macroeconomic accounts Viz: balance of payments (external sector), Government account (fiscal sector) and monetary account (monetary sector). Oke, 1995 presented a table that captures the fiscals, monetary and external sectors in the financial programming as follows:

Table 2.1: A three sector financial programming framework.

Fiscal sector	**Monetary sector**	**External sector**
GR – GE = D = ΔNCG	$\Delta NDC + \Delta NFA + \Delta OAN = \Delta M_2$ or $\Delta NFA + \Delta NDA = \Delta M_2$	CA + KA = ΔNFA

Where; ΔNCP = Net change in credit to the private sector, CA = Current account balance (export (x) - import (m)), KA = Capital account balance, ΔNFA = Net change in foreign asset, GR = Government Revenue, GE = Government expenditure, D = Budget deficits, ΔNCG = Net

change in credit to government, ΔNDC = Net credit to the domestic economy, ΔOAN = Change in net other assets, ΔNDA = Net change in domestic asset, ΔM_2 = Broad money supply.

The Framework that is presented by Oke, (1995) ignores the real sector and failed to reflect intergovernmental relationships (Garba, 2003). As a result, it may not be able to capture all the crucial routes through which crude oil price volatility can affect monetary policy and its effects on the economy. According to Garba, (2003), real sector activities such as employment, investment, consumption and output growth are ends of public policy and the success of public policy is determine by its impact on employment, incomes, output, consumption and welfare of the Public. Therefore, intergovernmental relationships are crucial to the success of public policy and hence the attainment of monetary policy objectives. Therefore, Garba, (2003), Ohuche,(2003) and others, presented a four components financial programming framework as a result of the inherent weakness of the three component financial programming framework. The four component framework is summarized below.

Table 2.2: Four component financial programming framework

Balance of Payment Account	**National Account**	**Fiscal Account**	**Monetary Account**
$\Delta R = X-Z+F$ $= X - Z + \Delta D^G$	$Y = E + X - Z$	$G - T = \Delta B + \Delta D^G + \Delta D^P$ $= \Delta D^G + \Delta D^P + \Delta R$	$\Delta M = \Delta D + \Delta D^R$

Where, M = Money supply, D = Domestic credit, R = Foreign reserve, ΔR = R - Rt = Balance of payment, P = Price level, Y = Real income, V = Velocity, X = Real exports, P^X = Price of exports, Z = Real imports, P^Z = Price of imports, F = Capital inflow, M = Propensity to invest.

The four components Financial programming was developed by Considering key economic relationships and relying on judgments and econometric projection techniques. Financial programming involves the four macroeconomic accounts which include National

Account(Real sector), Balance of payments (External sector), Government Account (Fiscal sector) and Monetary Accounts (Monetary sector)

Monetary Survey

Monetary survey is the core of money and banking statistics, monitoring some of the most useful monetary aggregates for economic analysis. Data for monetary authorities and deposit money banks are consolidated into a monetary survey. The monetary survey measures the size and origin of narrow money (M1) which includes transferable deposits and currency outsides banks, and quasi money which consists of the liabilities of these institutions in the form of time and saving deposits in addition to foreign currency deposits. Broad money (M2) consists of narrow money plus quasi money, and it equals total liabilities of the monetary survey.

Table 2.3: Assets and liabilities of the CBN

ASSET	LIABILTIES
Net foreign assets	Broad money M2
Domestic credit	Narrow money (M1)
Claims on Government Net	Currency in circulation
Claims on others	Demand deposits
Quasi money	
Time and saving deposit	
Foreign currency deposit	
Other asset Nets	

Net Foreign Assets is the sum of the monetary authorities foreign assets (gold holdings of SDRs, reserve position in the fund, foreign exchange (convertible / nonconvertible), regional monetary co-operation funds and other foreign assets) and other money deposits banks foreign assets (gold and other precious metals, claims on nonresident banks (example shares in non-resident banks, foreign currency) and claims on other nonresident (example claims on foreign government in the form of treasury bills and loans) less any foreign liabilities. Net Credit to Government consists of CBN credit to the Government and deposit money bank credit to the

Government . That is it also includes other domestic institution's credits of non financial public enterprises, non monetary financial institutions, private businesses, households and non-profit institutions. These claims on domestic sectors include bills, bonds and securities, loans and advances as well as credit.

On the liability side, the monetary survey shows the overall liquidity generated by the banking system, the stock of money if defined narrowly; consist of currency in circulation outside banks plus demand deposits in banks. A broader definition of money includes in addition to narrow money, quasi money that consist of time, savings and foreign currency deposits in the banking system. The discussion above is explained numerically below.

The consolidated balance sheet approach will be used to analyze the effect of crude oil price volatility on monetary policy variables in this study. The consolidated balance sheet model for broad money (M_2) supply is made up of narrow money supply (M_1) and quasi money (Q_m). It is given by;

$$\mathbf{M_2 = M_1 + Q_M = NDC + NFA + OAN} \quad \text{.....} \quad \mathbf{(2.8)}$$

From equation (2.8), narrow money supply can be defined as;

$$\mathbf{M_1 = D + C} \quad \text{.....} \quad \mathbf{(2.9)}$$

Also from equation (2.9), demand deposit is defined as;

$$\mathbf{D = BR + BC} \quad \text{.....} \quad \mathbf{(2.10)}$$

Where; NDC = Net domestic credit, NFA = Net foreign asset, OAN = Net other assets, D = demand deposits, C = currency in circulation, BR = bank reserves, BC = bank credits. Decomposing equation (2.8), net foreign asset (NFA) consist CBN assets (CBNA) and deposit money bank assets (DMBA). So, net foreign assets can be sensitive to crude oil price volatility

and may also cause movements in broad money supply. See chapter three for further information on the effects of crude oil price volatility on net foreign asset.

NFA = CBNA + DMBA ..... (2.11)

Similarly, net domestic credit (NDC) consist net credit to the Government (NCG) and credit to the private sector (CPS).

NDC = NCG + CPS ..... (2.12)

If NCG is decomposed further, we have CBN credit to the Government (CBNCG) and deposit money bank credit to the Government (DMBCG);(it also included other domestic institution's credits, non financial public enterprises, non monetary financial institutions, private businesses, households and non-profit institutions. These claims on domestic sectors include bills, bonds and securities, loans and advances as well as credit). Credit to the private sector consist CBN credit to the private sector ($CBNCP_s$) and deposit money bank credit to the private sector ($DMBCP_s$)

DCG = CBNCG + DMBCG ..... (2.13)

CPS = CBNCPs + DMBCPs ..... (2.14)

Therefore, monetary policy is usually designed to affect the quantity and price of financial assets used mainly for transactional, precautionary and speculative purposes. Expansion of aggregate money supply over and above the desired level (at a given cost or interest rate) may increase the demand for goods and services and thereby resulting to inflationary pressure (assuming the economy's output cannot be increased in the short run) or a loss of foreign exchange reserves or both. So, investigating the impact of crude oil price volatility on monetary policy is worth pursuing using this framework.

2.2.3 Transmission Mechanism of Crude Oil Price Volatility to Monetary Policy

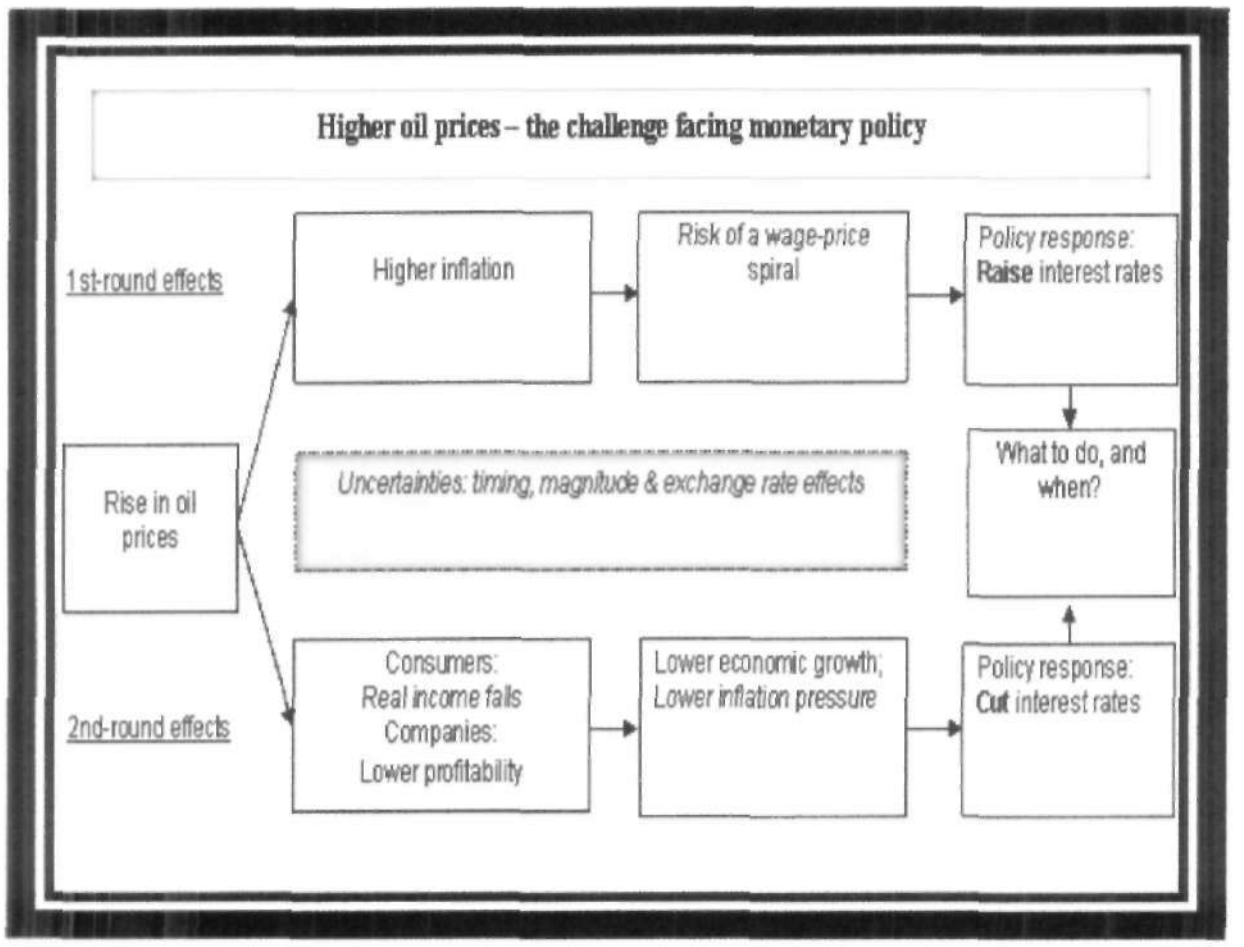
The transmission mechanisms, according to Jin (2008) through which oil prices affect real economic activity include both supply and demand channels. The main effect of rising oil prices in the short run is on aggregate supply. The supply side effects are related to the fact that crude oil is a basic input to production, and an increase in oil price leads to a rise in production costs that induce firms to lower output. Higher price causes an inward shift in short run aggregate supply and puts upward pressure on the general price level. This is an example of an 'exogenous inflationary shock'. Higher oil prices act as a dampening effect on the rate of growth of real GDP. This is because higher prices of oil reduce people's real incomes and their real purchasing power (Riley, 2006). And because firms are making less profit (because of higher costs) this can lead to a reduction in planned capital investment. Since both consumption and investment are important components of aggregate demand, the result can be a slowdown in growth leading to actual GDP falling below potential – i.e. a negative output gap (Riley, 2006).

The demand side effect is derived from the fact that oil price changes affect both consumption and investment decisions. Consumption is adversely affected because increase in oil price affects disposable income and the domestic price of tradable. Investment also is affected because such increase in oil price also affects firms' input prices and thereby increasing their costs. This reduces output growth and slower growth will have effect on employment because not just in those industries that depends on oil but across the whole economy. Another effect of rising oil prices could be to erode business confidence. This too will have a negative effect on output and investment intentions. Similarly a reduction in company profits might have a negative effect on share prices, falling share valuations effectively increases the cost of capital for firms wanting to

issue new shares to finance an expansion and a decline in equities would also hit consumer confidence (Riley, 2006). The actual effect of higher oil prices on world economic growth depends in part on what those countries that are accumulating huge trade surpluses as a result of being oil exporters, decide to do with these surpluses (Riley, 2006).

The transmission channel from oil prices to CPI may obviously generate some "second round effects" which are the ground for a wage-inflation spiral. Indeed, workers may want to adjust their nominal wages to rising oil prices and to the general price level in order to maintain their real wages (Riley, 2006). Higher oil prices will increase the cost of imports of crude oil, but the value of exports of Bonny light crude also rise. The net effect could be positive for the current account of balance of payments. However exporters of non-oil products may suffer from the oil price shock (Riley, 2006). Since higher oil prices reduce real incomes of oil consumers around the world, firms suffer not only from a drop in demand in their home market but from overseas as well. So exports fall causing a reduction in aggregate demand and exacerbating the fall in GDP growth. An oil-price increase leads to a transfer of income from importing countries to exporting countries through a shift in the terms of trade – i.e. the terms of trade for oil importing countries gets worse because they are now paying more per barrel of oil – and therefore having to export a greater volume of exports to pay for this (Riley, 2006). Conversely, higher oil prices improve the terms of trade for the leading oil-exporting countries. Their oil is worth much more on the global market, their potential export revenues are much higher as a result and this is will be an injection of income and demand into their circular flow (Riley, 2006).

Figure 2.1: Crude oil price volatility and monetary policy



Source: Adopted from Riley, (2006)

The relationship between oil prices and interest rates is rather intuitive and theoretically well established, a Central Bank that is designed to maintain price stability should react to the inflationary pressures entailed by oil price increases by raising its interest rate (Riley, 2006). Actually, when energy prices are rising, the consumer price level is likely to be affected rather quickly in two ways: directly via the prices of refined products (gasoline, kerosene) which are included in the consumer price index, and indirectly through the production costs which pass

through to the selling prices of final goods and services. Therefore, will higher oil prices also lead to an increase in interest rates? In theory it might well be the case because higher crude oil prices will feed through to an increase in the general price level and may threaten to take consumer price inflation above the Government target (Riley, 2006).

2.2.4 Crude Oil Price Volatility and Monetary Policy Management

Since the oil price shocks of 1973-74 and 1979-80, dozens of academics and practitioners have explored the relationships between oil price shocks and the macroeconomic variables. The recessionary impacts of these oil prices shocks were too close for possible causal links to be ignored, and considerable attention has been devoted to study the macroeconomics of these events.

Two fundamental propositions about the effect of the quantity of money on the economy predate the emergence of monetary economics as a recognized discipline of study. The first is that increases in the quantity of money that is not associated with corresponding increases in real output will eventually lead to inflation, and the second is that a shortage of money can depress the volume of economic activity. A considerable literature has emerged, attempting to give credence or discordance to these propositions, using restricted multivariate time series models as Sims and Zha (2005).

Milton Friedman and Anna Schwartz (1963) inspired the campaign in their seminal work as they documented the strong time series correlation of monetary aggregates with both output and prices. They explain that these correlations did not primarily represent passive responses of monetary aggregates to development in the private sector, but instead mainly the effects on monetary policy shifts on the private sector (Nagel and Parker, 2003). Literature has identified several factors that determine the capacity of Central Banks to use monetary policy to achieve

countercyclical objectives in the economy, one of such factors is the credibility of monetary policy. In this regard, credibility refers to the level of commitment of the Central Bank to following a set down monetary policy rule rather than following a discretionary approach. This is important because economic agents make their decisions based on the expected course of monetary policy as well as the current policy.

Also, policy transparency which deals with the extent of policy disclosure and the timing of Central Bank communication are key success factors in evaluating the effectiveness of monetary policies as shown by Ehrmann and Fratzscher (2007) and Geraats (2005). However, Bernanke and Mihov (1998) and Leeper et al. (1996) prefer to make the case for the choice of the monetary instrument used for intervention as the major determinant of the degree of impact. They both submit that the traditional approach of using changes in the money stock to stimulate or depress economic activity is inferior to the use of interest rates. This is because the growth rate of monetary aggregates depends on a variety of non-policy influences. Other authors like Cochrane (1998) emphasize anticipation or non-anticipation by agents as the key factor. Starr (2005), in the spirit of new Keynesianism, focused on the sticky and flexible nature of prices.

Therefore, no matter the opinion that different authors may hold about the effectiveness of monetary policy, it is certain that the effectiveness of monetary policy shocks, is a function of a compound set of variables. In developed economies, such as the United States and some core European countries, there is substantial evidence of the effectiveness of monetary policy on real economic parameters. (Mishkin, 2002; Christiano et al., 1999; Rafiq and Mallick, 2008 and Bernake et al., 2005). However, for developing countries like Nigeria, the evidence is weak and full of "puzzles". For example, Balolgun (2007) used simultaneous equation models to test the hypothesis of monetary policy effectiveness in Nigeria and find that, rather than promote growth;

erstwhile domestic monetary policy was the source of stagnation and persistent inflation. Similar evidence was also found for the Gambia, Guinea, Ghana and Sierra Leone using the same models.

Rahman and Mustafa (2008) carried out a study on the Influence of money supply and oil price on US stock market. The work studied the long-run and short-run dynamic effects of broad money supply (M2) and oil price on US stock market (S&P500). Monthly data from 1974 through April 2006 was employed with each variable non stationary at levels. The three variables depicted co-integrating relationship and the vector error correction mechanism model did not reveal any converging long-run causal flows, although short-run interactive feedback relationships existed.

Gramlich (2004) opined that monetary policy makers have understood from past experiences that oil shocks will result in some combination of higher inflation and higher unemployment for a time. He conclude that the worst possible outcome is not the temporary increase in inflation and unemployment but that the worst possible outcome is for monetary policy makers to let inflation come loose from its moorings. Ferderer (1996) clearly delineated the theories that may explain the macroeconomic consequences of oil price changes. The two mechanisms for the relationship between oil price changes and the macro economy that are best supported by his empirical study are also the two that generalize to other commodities. In other words, they imply that price volatility for any commodity that is an input to production will cause negative impacts on the macro economy.

The first of these mechanisms is sectoral shocks: some labor and capital are dedicated to a particular production process or industry and it is costly to move them to another industry. Therefore price changes – in any input or output – that change the optimal allocation of labor and

capital across industries will be costly to the macro economy. The second mechanism is the option value of delaying irreversible investment when there is uncertainty about the future level of prices for inputs or outputs.

Mysen (1994), Bruno and Sachs (1985) Helliwell (1988) Hooker (2002) opine that the theoretical result that energy price shocks may trigger an external inflation spike has been pervasive in the literature. Similarly, other important studies, including DeLong (1997), Barsky and Kilian (2001), Hooker (1999), and Clarida, Gal'i and Gertler (2000), suggest that different monetary policy (particularly prior to the oil shocks) could have substantial impact on inflation.

Roubini and Setser (2004) carried out a study on the effects of oil price shock on the US and global economy. They find that oil price shock has stagflationary effect on the macro economy of oil importing countries. According to them, oil price shock slow down the rate of growth and even reduce level of output. However, Kilan (2009) opined in his study oil price volatility: origin and effects that there has been increasing recognition of the importance of shift in the demand for oil and recent research has provided robust evidence that oil demand shocks played a central role in all major oil price shock episodes since the 1970s. According to him, recent research shows that shocks to the flow supply of crude oil overall had little impact on the real price of oil since 1973. In contrast, shocks to the flow demand for oil associated with the global business cycle have been responsible for long swings in the real price of oil, notably in 1973/74, 1979/80 and 2003-2008.

Guo and Kilesen (2005) examine the price volatility on US macroeconomic activity. The study used the time series data between 1984 to 2004 on fixed investment, consumption, employment and the unemployment rate. The econometric techniques adopted for the study are ADF unit root test and Granger Causality. The study's findings supported Hamilton (2003 and 1996)

which confirms the result that oil price volatility had a significant adverse effect on US macro economy. The findings also showed that changes in the Supply and Demand of crude oil price tend to reflect stochastic disturbance.

Masih et al (2010) examined oil price volatility and stock price fluctuation in emerging markets, evidence from South Korea. He finds that oil price volatility have profound effect on the time horizon of investment and firms need adjust their risk management procedures accordingly, A vector error correction mechanism model with interest rate, economic activity, real stock, returns, real oil price and oil price volatility were used and result indicates the dominance of oil price volatility on real stock returns.

Frankel (2006) examined the Impact of monetary policy on commodity prices. He opined that monetary policy makers should look at everything, that it is obvious that an index of agricultural and mineral commodity prices belong to a useful list of variables that reveal current monetary conditions, alongside short and long term interest rates, the exchange rate, housing prices and the stock market. Berumet and Ceylan (2005) also studied the effects of symmetric oil price shocks on output for a group of Middle East and North African countries. Using impulse response and variance decomposition analysis, they find that the effects of world oil price shocks on GDP of Algeria, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, Tunisia, and UAE are positive and statistically significant. However, for Bahrain, Egypt, Lebanon, Morocco and Yemen, they found the existence of positive but not significant impacts.

Rajhi et-al (2005) carried out a cross country investigation on twenty four African economics. Annual data from 1960 to 2000 using times series data on Gross Domestic Product, Consumer Price Index, Current Account Balance, overall budget balance and total reserves. The ADF unit root test, co-integration technique and Granger Causality test were used and their findings

showed that African economies are influenced by fluctuations in oil prices in the long run for some countries and via short run for others. In another work, Jbir and Zounari-Ghorbel (2009) studied the impacts of the recent oil price shocks on the Tunisian economy focusing on role of subsidy policy and found from their linear and non-linear specification of the OPM model that there is no direct impact of oil price shocks on economic activity in Tunisia.

Focusing on studies on Nigeria, Olomola and Adejumo (2006) examined the effects of oil price shocks on output, inflation, real exchange rate and money supply in Nigeria found that oil price shocks significantly affect the money supply in the long-run. They conclude that their results suggest the tendency for the Dutch disease. However, Ayadi (2005) focus on the relationship between oil price changes and economic development via industrial production in Nigeria using a VAR system. His result suggest that oil price changes affects industrial production indirectly through its effect on exchange rate, though, he summits that this relationship is insignificant.

Akpan (2009) study the asymmetric effects of oil price shocks on the Nigerian economy. The findings from her study show a strong positive relationship between positive oil price changes and real government expenditure. Also, the impact of oil price shocks on industrial output growth was found to be marginal with observed significant appreciation of the real exchange rate. A finding which reinforces that of Olomola and Adejumo (2006) and Ayadi (2005) that oil price shocks tend to create the tendency for the Dutch disease syndrome in Nigeria.

Recently, Aliyu (2009) used a non-linear approach to investigate the OPM relation in Nigeria and find evidence of both linear and non-linear impacts of oil price shocks on real GDP. The results of the asymmetric oil price increases in the non-linear models are found to have positive impacts on real GDP growth of a larger magnitude than for other specifications; a result that is an aberration from the previous empirical works earlier reviewed.

2.3 Overview of Monetary Policy in Nigeria

All over the world, the major preoccupation of Central Banks is the formulation and implementation of monetary policy. This is predicated on its use as a tool to enhance the macroeconomic environment, particularly an efficient financial system/market to promote economic growth. In developing economies, the Central Bank is further entrusted with other developmental functions with a view to engendering rapid economic development. In pursuance of these objectives, Central Banks are usually given the core mandate of maintaining internal and external value of the currency, which in the domestic economy translates to keeping inflation low and stable. Central Banks undertake an evaluation of the economy which forms the basis of monetary policy formulation and implementation. (Okafor, 2009)

Monetary policy influences the level of money stock and/or interest rate, for example availability, value and cost of credit in consonance with the level of economic activity. Macroeconomic aggregates such as output, employment and prices are in turn affected by the stance of monetary policy through a number of ways including interest rate or money, credit, wealth or portfolio and exchange rate channels (Uchendu, 2009). The monetary authorities apply their discretionary power of influencing the money stock and interest rate to make money either more expensive or cheaper depending on the prevailing economic conditions and policy stance, in order to achieve price stability. Monetary policy performance in Nigeria has undergone series of reforms between 1980 and 2010 and two major periods are worth discussing.

Direct Monetary Control (Pre-SAP Period) 1980-1985.

During the pre sap period, 1980-1985, the monetary policy framework placed emphasis on direct monetary control. This was due to relatively underdeveloped nature of money and

capital markets in the country then. The framework relied heavily on sectoral credit allocation; credit ceilings and cash reserve requirements; administrative fixing of interest rate and exchange rates; as well as imposition of special deposits (Uchendu, 2009). During period, the monetary authorities imposed differential quantitative ceilings on all sectors of the economy, given more of such ceilings to the preferred sectors of the economy. Agriculture, manufacturing and construction were the preferred sectors with respect to credit allocation below market lending rate. This was to ensure that these sectors were given the utmost attention to take the lead of growing the economy through the multiplier effect. The level and structure of interest rate were administratively determined by the CBN. Both savings and term deposit rates were fixed in order to attain the social optimum in resource allocation, promote growth of the preferred sectors and orderly growth of the financial market, contain inflation and lessen the burden of internal debt servicing of the government (Uchendu, 2009).

Available evidence during the period of direct control regime revealed that the flow of credit to the priority sectors did not meet the prescribed targets and failed to impact positively on investment, output and domestic price level. During the period, the average prescribed sectoral percentage distribution of commercial bank merchant bank to agriculture; manufacturing and others were 8.8%, 40% and 12.6 percent respectively (Okafor, 2009). A major factor which impaired the effectiveness of monetary policy during the era of direct control regime was lack of instrument autonomy by CBN, monetary policy at this period was mainly directed by ministry of finance and as such was influence by short term political considerations (Oke, 1995).

Indirect Monetary Policy Era (1986-2010)

In line with economic deregulation embodied by SAP, there was a paradigm shift from the hitherto repressive direct monetary control method to an indirect approach anchored on the

use of market instruments in monetary management. This was borne out of the desire to eliminate the distortions and inefficiencies in the financial system caused by the prolonged use of administrative controls and the need to engender competition among banks and other operators in the financial system.

Between 1986 and 2001, a number of monetary targets and instruments were adopted which were consistent with the broad objective of monetary policy in Nigeria (Uchendu, 2009). Open market operation was conducted using the Nigeria Treasury Bills (NTBs) which is the primary instrument of monetary policy. This was complemented by the cash reserve requirement (CRR) and the Liquidity ratio (LR). Other policy instruments employed included the discount window operations. Interest rate policy was deregulated through adjustment of minimum rediscount rate (MRR) to signal policy direction consistent with liquidity conditions (Uchendu, 2009). Surveillance activities of the CBN focus on sound monetary stability in the banking sector and the economy at large. Also, official and interbank exchange rates were unified in 1999. In spite of the monetary policy reforms during this period, the CBN was unable to attain monetary policy targets due to expansionary nature of fiscal policy by the Government and the resultant liquidity overhang as well as lack of harmony between monetary policy and fiscal policy. Inflation rate was largely double digit.

Furthermore, between 2002 and 2005, the CBN commenced a two year medium term monetary policy framework aimed at freeing monetary policy from the problem of time inconsistency and to minimize the effect of temporary shocks to monetary policies in Nigeria. Under this framework monetary policy was to half yearly review in the light of development in monetary and financial market conditions so that medium to long term goals may be achieved. Open market operations continued to be the major tool of monetary policy and were

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complimented by reserves requirement, discount window operations, foreign exchange market intervention and movement of Government deposits in and out of deposit money banks (Uchendu, 2009). The CBN also undertook banking sector reforms (13-point reform agenda) in 2004. Fiscal discipline was pursued by the Federal Government and monetary policy performance was fairly effective over the period.

The post consolidation period 2006 to 2010 witnessed a lot of policy measures which included zero tolerance for ways and means advances, gradual run down of CBN holding of treasury bills, proactive liquidity mop up, monetary policy rate (MPR) replaces minimum rediscount rate (MRR) in 2006, unremunerated reserve requirement, increase coordination between the CBN and the Federal Government, restructuring of debt instruments, increased deregulation of foreign exchange market and occasional foreign exchange swap (Uchendu, 2009). In 2009 and 2010, some of the reforms included promoting agriculture through commercial farming, financial bailout of distress deposit money banks, introduction of sovereign wealth fund etc. All these measures were aimed at minimizing shocks to monetary policy in Nigeria.

2.3.1 Conduct of Monetary Policy in Nigeria

The major objective of monetary policy of the CBN is the maintenance of price stability consistence with non-inflationary growth among others. The achievement of the policy objectives depend on various factors including monetary policy transmission mechanism, technological development, institutional capacity, availability of instruments and the relationship between the banks, Government and its agencies and the private sector (Mordi, 2009). The ultimate targets are low inflation and sustainable growth of output. However, there is no direct link between the instruments of monetary policy and the ultimate targets hence the need for

operating targets. Under this framework, the operating target is the base money while the broad money supply is the intermediate target. The operating target (base money) links the Central Bank instruments and intermediate targets (money supply, credit, interest rate and exchange rate). The linkage is illustrated below.

Instrument ⟶ Operating target ⟶ Intermediate target ⟶ Ultimate target.

As described earlier, Nigeria is a developing economy with not so well developed domestic financial market hence the choice of quantity variable (base money) as operating target also because it has stable relationship with the intermediate target M_2. The setting of the intermediate and operating targets involves the determination of the optimal money supply that is consistent with the predetermined ultimate targets. Essentially, this step paves the way for obtaining an ex ante monetary survey (a consolidated balance sheet of the banking system that is, Central bank and deposit money banks), which is consistent with the overall monetary policy objectives. This is done within the context of financial programming methodology. The underpinning theory is quantity theory of money and this explains why the bank as most other Central banks targets money.

2.3.2 Analysis of Crude Oil Prices and Some Macroeconomic Variables in Nigeria.

Prior to 1980s, Nigeria had joined the organization of petroleum exporting countries (OPEC) in 1971 and the world crude oil prices were rising and experiencing boom. Government revenue and spending increased tremendously because of the oil boom, (Akpan, 2009). The production of crude oil was about 845.5 million barrels per day and sold at $33.2 per barrel in 1979.

Although the production of crude oil droped in 1980s due to global economic recession, it however rose slowly again in 1988. Crude oil prices exhibited downward trends from 1981 up to 1989 when a slight rise was recorded, (see table 2.1). Between 1980 and 1989, the downward trends in crude oil production and prices were largely due to the economic recession that ravaged the market. It is important to mention that between 1980 and 1989, money supply was expansionary in nature in Nigeria. The CBN undertook an expansive monetary policy in order to accommodate public sector's demand for credits. This is seen by the upward trends in the money supply graph (see figure 2.3). Also real output performed poorly in 1982, 1983, 1984, 1986 and 1987.

The poor performance of the real sector was largely due to administered exchange rate and interest rates regimes which were fairly stable over the period, (Oke, 1995). The then overvalued Naira and interest rates could not transform national savings into productive investments. Net foreign assets and external reserves fluctuated with the decline in crude oil prices caused by the oil glut. Crude oil exports and imports declined in 1982 and rose again in 1986 when the structural adjustment programme (SAP) was adopted. The degree of trade openness was highest, 4.6 in 1986 and range between 1.5 and 4.6 for the period 1980 and 1989. See table 2.1 for detail statistics. Between 1990 and 1999, crude oil prices were still between $12.8 and $24.2 up to 1999 when it rose to $71.8. However, crude oil production was relatively stable within the same period. According to Umar and Abdulkareem, (2010), the rise in crude oil prices in 1999 was largely due to some factors. Firstly, OPEC restricted crude oil production to certain quantity and there was greater cooperation among member states. Secondly, the growing demand for crude oil from Asia significantly increases the oil price crisis. And thirdly, shrinking non OPEC production level. These factors made the world to respond by offering higher prices for crude oil.

Within this period also, the CBN continued to pursue expansionary monetary policy to accommodate Government demand for credits. The rate of inflation was largely double digit and real output growth was very small. In fact, there were periods where the country recorded zero real output growth in 1991. It is important to mention that the country changed from SAP programme and adopted a policy of guided deregulation in 1993 and 1995 and as a result exchange rate and interest rate regimes was regulated until 1999 when the flexible model was introduced. By 1994 and 1999, external reserves and net foreign assets had risen to $7.94 billion and 666.3 billion Naira respectively. Crude oil exports and import continued to rise in the same direction. The reason for the rise in import bills of crude oil was the failure and under utilization of the existing refineries in Nigeria (Akpan, 2009). Degree of trade openness range between 1.1 and 2.4 for the period 1990 and 1999.

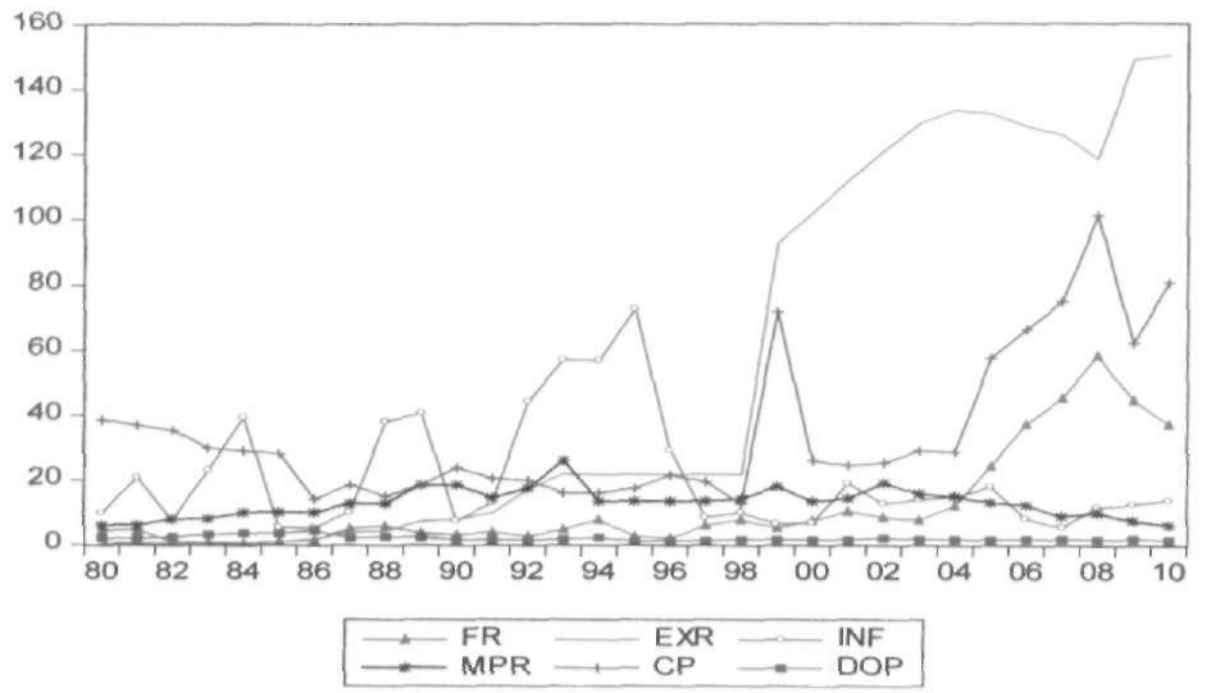
Table 2.4: Crude oil price and some macroeconomic variables in Nigeria

Year	M_2	NFA	RGDP	FR	QCP	CP	EXR	INF	MPR	OX	OM	DOP
1980	15.1	5.62	31.5	4.57	760.1	38.8	0.546	9.9	6.0	13.63	0.23	2.1
1981	16.2	2.59	205.2	4.68	525.3	37.1	0.610	20.9	6.0	10.68	0.12	2.0
1982	18.1	0.89	199.7	1.03	470.8	35.6	0.673	7.7	8.0	8.00	0.23	2.6
1983	20.9	0.50	185.6	0.60	451.0	30.0	0.724	23.2	8.0	7.20	0.17	3.2
1984	23.4	1.11	183.6	0.46	507.5	29.2	0.765	39.6	10.0	8.84	0.28	3.7
1985	26.3	1.42	201.0	0.98	547.1	28.2	0.893	5.5	10.0	11.22	0.05	3.6
1986	27.4	5.37	205.9	1.58	535.9	14.2	2.021	5.4	10.0	8.37	0.91	4.6
1987	33.7	3.70	204.8	5.22	483.3	18.5	4.018	10.2	12.8	28.21	3.17	2.2
1988	45.4	9.49	219.9	6.02	529.8	15.1	4.537	38.3	12.8	28.44	3.80	2.6
1989	47.1	22.52	236.7	3.66	625.9	18.6	7.392	40.9	18.5	55.02	4.67	2.4
1990	68.7	43.91	267.5	3.36	660.6	24.0	8.038	7.5	18.5	106.63	6.07	1.7
1991	87.5	56.05	265.4	4.05	689.9	20.5	9.910	13.0	14.5	116.86	7.77	1.5
1992	129.1	35.78	271.4	2.78	711.3	20.0	17.29	44.5	17.5	201.38	19.56	1.5
1993	198.5	63.56	274.8	4.90	691.4	16.0	22.05	57.2	26.0	213.78	41.14	1.8
1994	266.9	56.22	275.5	7.94	696.2	16.2	21.88	57.0	13.5	200.71	42.35	2.4
1995	318.8	108.66	281.4	2.69	715.4	17.4	21.88	72.8	13.5	927.57	155.83	1.1
1996	370.3	237.98	293.8	2.16	740.2	21.6	21.88	29.3	13.5	1,286.2	162.18	1.4
1997	429.7	234.02	302.8	6.12	759.7	19.5	21.88	8.5	13.5	1,212.5	166.90	1.3
1998	525.6	247.04	310.9	7.81	776.0	12.8	21.88	10.0	14.3	717.79	175.85	1.7
1999	699.7	666.27	312.2	5.33	778.9	71.8	92.69	6.6	18.0	1,169.5	211.66	1.6
2000	1,036.1	1,275.0	329.2	7.59	797.9	26.1	102.10	6.9	13.5	1,920.9	220.82	1.6
2001	1,315.9	1,347.6	357.0	10.28	817.2	24.5	111.94	18.9	14.3	1,839.9	237.11	1.5
2002	1,599.5	1,282.2	433.2	8.59	655.1	25.4	120.97	12.9	19.0	1,649.4	361.71	2.1
2003	1,985.2	1,388.2	477.5	7.64	655.1	29.1	129.46	14.0	15.8	2,993.1	398.92	1.6
2004	2,263.6	2,644.7	527.6	12.06	900.6	28.7	133.50	15.0	15.0	4,489.5	318.11	1.7

2005	2,814.8	4,098.5	561.9	24.32	919.3	57.6	132.15	17.9	13.0	7,140.6	797.30	1.5
2006	4,027.9	6,307.9	595.8	37.46	814.0	66.5	128.65	8.2	12.3	7,191.1	710.68	1.8
2007	5,832.5	7,266.5	634.3	45.39	784.8	75.0	125.83	5.4	8.8	8,110.5	768.23	1.7
2008	9,208.5	8,550.4	674.9	58.47	722.7	101.2	118.57	11.6	9.8	9,913.7	1,386.7	1.6
2009	9,615.2	7,557.3	716.9	44.70	664.3	62.1	148.90	12.4	7.4	8,067.2	1,063.5	1.8
2010	11,154.8	7,673.7	765.0	37.36	777.5	80.8	150.29	13.8	6.1	10,639.4	2,073.6	1.5
Average	**1,749.11**	**1,651.44**	**348.48**	**11.93**	**682.74**	**34.91**	**54.32**	**20.81**	**12.9**	**2,267.35**	**301.28**	**2.04**

Source: CBN Statistical Bulletin 2010, Annual Report and Statement of Account, Various Issues
Where; ***M_2*** *=broad money supply (in billion Naira) ,* ***NFA*** *= net foreign assets (in billion Naira),* ***RGDP*** *= real income (in billion Naira),* ***FR*** *= foreign or external reserves (in billion U.S. Dollars),* ***QCP*** *= quantity of crude oil production (in million barrels per day),* ***CP*** *= crude oil price (in U.S. Dollars),* ***EXR*** *= Naira exchange rate per U.S Dollars,* ***INF*** *= inflation rates (in %) ,* ***MPR*** *= monetary policy rates (in %),* ***OX*** *= crude oil exports (in billion Naira) ,* ***OM*** *= crude oil imports (in billion Naira),* ***DOP*** *= degree of trade openness.*

Figure 2.2: Trends in crude oil prices and some economic variables



In the period between 2000 and 2010, crude oil prices fell to $26.1 in 2000 due to the mild recession that affected the world in late 1998 and 1999. Note that crude oil production drop in Nigeria due to the Niger-Delta militancy that disrupted production. Before 2010, crude oil prices

had risen to $57.6 in 2005 and reached a high level of $101.2 in 2008. The 2007/2008 global recession result to a downward fall of crude oil prices in 2009 and a rise in 2010 (see table 2.1 and figure 2.2). Also, money supply has being on the rise, reaching its highest growth rate of 57.9% in 2008. Real output growth rate improved between 2000 and 2010, reaching a period average of 6.25% (see figure 2.3). In a bid to promote real production in Nigeria, the value of the Naira depreciated further while interest rate regime reduced from double digits to single digits. Although inflation rates were still high, the growth of non oil output increased significantly in the economy. Net Foreign Asset and external reserve reached their peak of 8,550.4 billion Naira and $58.5 billion in 2008 respectively (see table 2.1). This suggests that when crude oil price rises, net foreign asset and external reserve also rises. Crude oil export and import have continued to rise, reaching their peak in 2010. The break down and the under utilization of some domestic refineries in Nigeria have increased the import bills for crude oil, (Akpan, 2009). However, degree of trade openness ranges between 1.5 and 2.1 for the period 2000 to 2010.

Figure 2.3: Trends in crude oil production and some macroeconomic variables

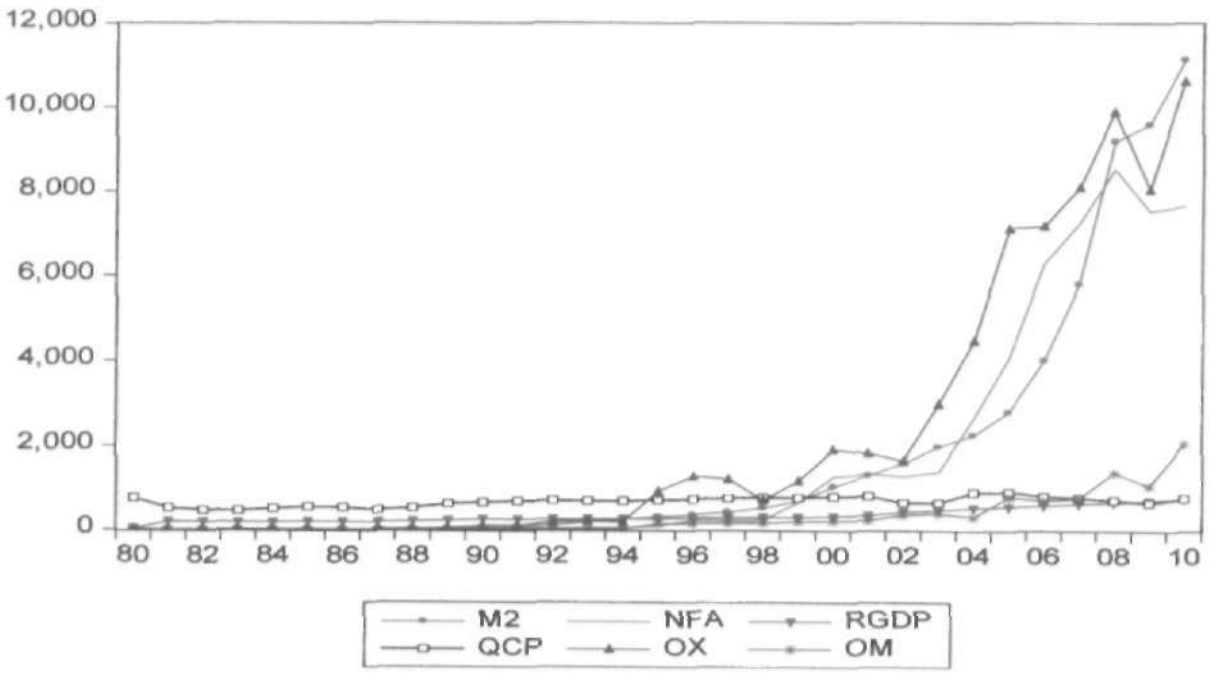
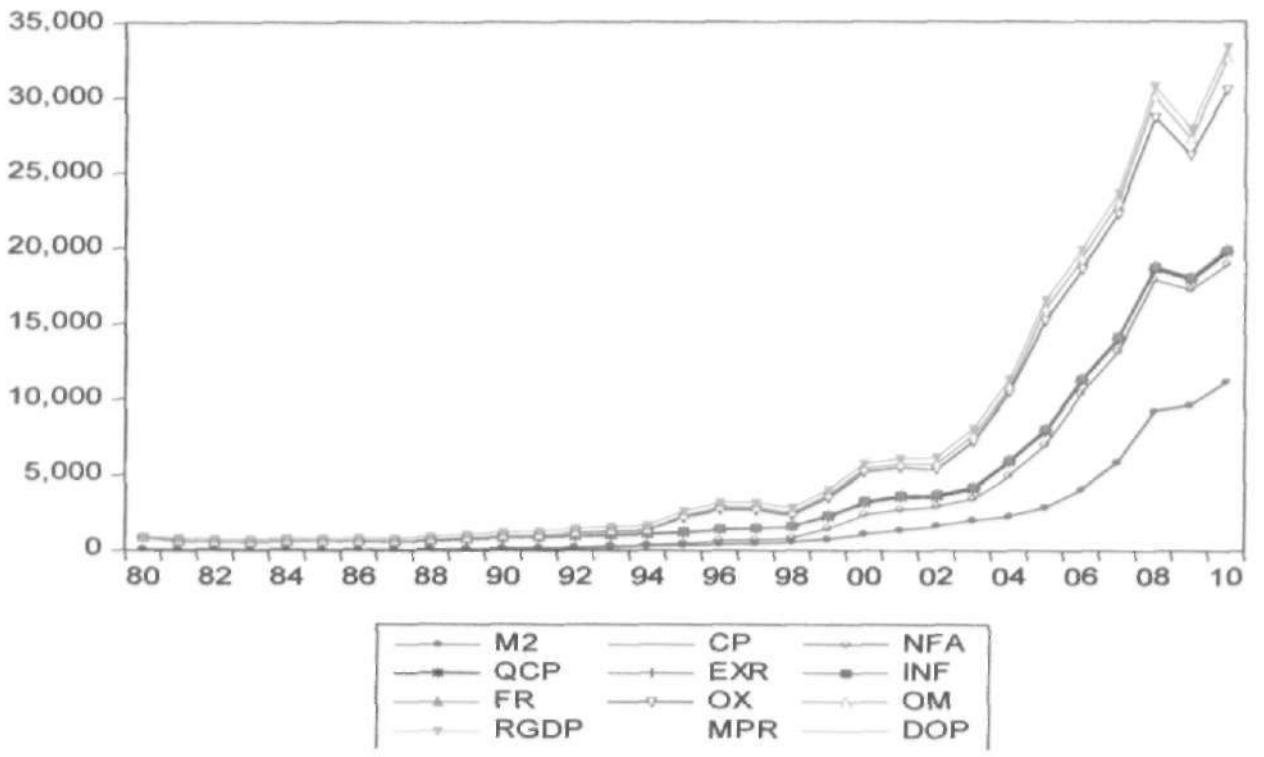


Figure 2.4 shows the graph of variables in table 2.1 stack in one diagram. As the name suggests, these graphs are sums of the variable series in the table. The first graph element will be the first variable series plotted in the usual way; the second element will be the sum, for every observation, of the first variable series and the second. The third element will contain the sum of the first three variables series, and so forth. The graph shows that the variables exhibited similar pattern of behaviour (trends) when they are linearly combined (Eviews 4).

Figure 2.4: Graph of variables stack in a single graph.



Between 1980 and 2010, crude oil prices averaged $34.91 while total crude oil production stood at an average of 682.74 million barrels per day. Total money supply within the period averaged 1,749.11 billion Naira. The period average for real output (GDP) was 348.48 billion Naira. The average inflation, interest rate and exchange rate depreciation was 12.9%, 20.81% and 54.32 Naira per U.S Dollar respectively. The period average for net foreign asset

and foreign reserve were 1,651.44 billion Naira and $11.93 billion respectively. Similarly, crude oil export and import averaged 2,267.35 and 301.28 billion Naira respectively for the period. The degree of trade openness had a period average of 2.04 between 1980 and 2010, (see table 2.1 above). Therefore, although past studies have established the transmission mechanism of crude oil price effect in developed countries, crude oil price movement could significantly have impact on monetary policy, net foreign asset, crude oil export and import in Nigeria.

2.4 Review of Empirical Literature

With increasing interest in price stability, there is a growing body of empirical and theoretical literature that analyses the impact of crude oil price volatility on monetary policy. Many empirical studies present evidence proving a negative association between these variables through diverse econometric analytical methods. We will classify the empirical literatures into Nigerian studies and studies in other countries.

2.4.1 Non-Nigerian Studies

Bruno and Sachs (1982) analyzed in detail the effects of oil prices of the 1970s on output and inflation in the UK. They took the case of UK manufacturing and developed a theoretical model and concluded that higher input prices have played a significant role in the slowdown since 1973 throughout the Organization for Economic Cooperation and Development (OECD). Hamilton, (1983) in a study on the subject established a vital role for oil price increase in most of US recessions. He stresses the importance of oil prices on macroeconomic activities.

Many studies that supported and expanded on Bruno and Sachs (1982) and Hamilton, (1983) earlier works, while using different estimation procedures and data tested the relationship between oil price increase and different macro-economic variables, (Buridge and Harrison,1984), (Gisser and Goodwin,1986), (Mork 1989), (Hoover and Perez 1994), (Federer 1996) and (Lee

et al, 1995). Most of the studies have focused on the industrialized countries, restating that oil prices may be an important factor in affecting economic growth in the US and elsewhere. These studies showed that there is an asymmetric relationship between oil price shocks and economic recession. Some studies have established that the increase in oil price led to a decline in GDP while the decrease in oil price does not stimulate the economic activity.

Balke et al (2002) gave an explanation of the asymmetric effects oil price shocks have on macroeconomic activity. According to them, monetary policy alone cannot explain real effects of oil price shocks on real GDP. They also concluded that interest rates seem to be an important mechanism through which oil prices affect economic output. Lee et al. (1995) also revealed the stability of asymmetric effects in the period before and after 1985 and whether or not it depended on other variables. The implication of this study is that indirect transmission mechanisms may be the crucial means by which oil price shocks have macroeconomic impacts.

In addition, Mork (1989), Mork, et al (1994) Huang, et al. (2005), Sadorsky (1999) also emphasized the asymmetry of the impact of oil price shocks on economic activities. The basis for their argument was the oil price declines of the mid-1980s during which the world price of oil halved. The linear relationship between oil prices and economic growth appeared to break down. Hooker (1996) argued that the relationship oil price- US economic growth had changed and could not be described neither by a linear relation between oil prices and output nor by the asymmetric relation presented by Mork (1989) after 1986 and increasing oil price volatility. Hooker's analysis could not confirm that only oil price increases have a negative effect on economic growth, while oil price decreases don't affect macro economy. These results were completed by subsequent studies.

Hamilton (1996) agreed with Hooker and found out that the majority of increases in oil prices since 1986 have been followed immediately by even larger decreases. Therefore, he proposed to compare the current price of oil with the price level of the previous year rather than only compare it with the price level of the previous quarter; he introduced the 'net oil price increase' (NOPI). Applied on the data after 1986, it showed that individual price increases were simple corrections to earlier declines except for the time during the Gulf war, which was followed by the first recession in the US. In contrast to Hooker, Hamilton demonstrated that the relation between GDP growth and NOPI remains statistically significant when the full sample from 1948:1 to 1994:2 was used. Thus, Hamilton concluded that even if oil price increases seemed to have had a smaller macroeconomic effect after 1973, oil supply disruptions have a major effect on macro economy as the Gulf war showed. In a related study, Hsing (2007, 2008) focused on the non- linear relationship between real output and real oil prices applying the monetary policy function to an open economy and found the critical value of oil prices for Germany and US.

Farzanegan and Markwadt (2007) carried out an investigation on the effect of oil price shock on the Iranian economy and finds that oil price shocks have a special impact on the Iranian economy due to the high level of dependence on oil revenues. By applying a VAR approach, the work analyses the dynamic relationship between asymmetric oil price shocks and major macroeconomic variables in Iran. Farzanegan and Markwardt (2009) also studied further the effects oil price shocks on the Iranian economy and found a strong positive relation between positive oil price changes and industrial output growth and observe the Dutch disease syndrome through significant real effective exchange rate appreciation. Conversely, the study by Chang and Wong (2003) on the Singaporean economy show that the impacts of oil price shocks only

had an insignificant adverse effect on Singapore's gross domestic output, inflation and unemployment rate.

Guo and Kliesen (2005) also found the negative and significant effect of oil future prices on future Gross Domestic Product, and discovered that this effect became more significant after oil price changes were also included in the regression to control for the symmetric effect. His findings were in confirmation with Hamilton (1996, 2003), that is, increase in the price of oil matters less as compared to the future uncertainty about the direction of prices. As oil price volatility is mainly driven by exogenous events such as significant terrorist attacks and military conflicts in the Middle East and youth restiveness especially in the Niger Delta region of Nigeria. His findings provide economic rationales for Hamilton's (2003) non-linear oil shock measure, as it captures overall effects, both symmetric and asymmetric of oil shocks on output.

Krichene (2006) examined the relationship between monetary policy and oil prices within a world oil demand and supply model and discovered that during a supply shock, rising oil prices caused interest rates to increase, whereas during a demand shock, falling interest rates caused oil prices to rise. The result further revealed that world economic growth and price stability requires stable oil markets and therefore more prudent monetary policies.

LeBlanc and chinn (2004) estimated the effects of oil price changes on inflation for the United States, United Kingdom, France, Germany, and Japan using an augmented Phillip curve framework and found that current oil price increases are likely to have only a modest effect on inflation in the U.S, Japan, and Europe. However, Saunter and Awerbuch (2002) surveyed recent research in the area of oil price movements and their effect on economic and financial performance in IEA countries and found that there is negative relationship between oil prices and macroeconomic activity.

Torul (2009) investigated the effects of oil price changes on the real output for a net oil importing small open economy, Turkey, and found that the negative response of real output to oil price increases have diminished since the early 2000s. The conventional wisdom is that oil prices are more volatile than prices of most other commodities since the oil crisis of 1973 (Fleming and Ostidick, 1991; Veleger, 1993). This assumption has been used to justify prices and allocation controls and energy efficiency subsidies and recently has been the basis for recommendations for national energy policy to diversify energy sources away from oil (Awerbuch, 2003; Humphrey and Mc clain, 1998; lovins et al, 2004). The related assumption that prices for other energy products are more volatile than prices for non-energy products has been used to explain microeconomic behavior and in particular the perceived underinvestment in energy conservation technology by consumers and industry (Regnier, 2007). The question whether oil and energy prices are really more volatile than other commodity prices, or whether many commodity prices are actually more volatile than oil prices, has both macroeconomic and microeconomic implications.

However, Plourde and Watkins (1998) found that crude oil price volatility during the 1985–1994 period was higher than price volatility for nine other commodities and that the differences were significant for six of these. In a broad based comparison of commodity price volatility, Clem (1985) noted that during the 1975–1984 periods, agricultural commodities were the most volatile. Crude petroleum and coal were less volatile than most crude non food materials during the three periods he analyzed (1975–1984, 1979–1981, and 1982–1984); in particular, primary metals prices were noticeably more volatile than fuels prices.

Pindyck (1999) analyzed oil, coal, and natural gas price changes during the period 1870–1996, but did not compare their volatilities, and he calculated a constant volatility measure over a

very long period during which volatility is believed to have changed, a Mann– Whitney rank-sum test of log differences confirms that oil prices are significantly more volatile than over 93% of other commodities. The finding that oil price volatility is not as unusual as commonly believed also suggests that other factors make its price volatility so important: volatility in crude oil prices is largely passed to consumers who are usually somewhat insulated from volatility in production input prices, and fuels simply make up a very large portion of the basket of goods that producers and consumers purchase. Other characteristics of oil price dynamics, such as the rate of mean reversion and the correlation with other prices and macroeconomic variables, are also very important in determining the impact of changes in oil prices.

2.4.2 Nigerian studies

Chuku (2009) studied the effects of monetary policy innovation in Nigeria. He opined in his work that correctly identifying the effects of monetary policy innovations is necessary for good policy making. He used a structural vector autoregression (SVAR) model to trace the effects of monetary policy shocks on output and prices in Nigeria for the period 198:1 to 2008:4. He used three alternative policy instruments i.e. broad money (M2), minimum Rediscount Rate (MRR) and the Real Effective Exchange Rate (REER). Other variables considered are real GDP, CPI, and inflation rates. The study specified the model as;

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2,} + \ldots, + \beta_p Y_{t-p} + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.15)$$

Where, β_i (i = 1, 2, …, p) = k × k matrix of coefficients, β_0 = k × 1 vector of constants, U_t = vector of white noise process, and Y_t = vector of endogenous variables. The study found that monetary policy innovations carried out on (M2) has a modest effect on output and prices with a very fast speed of adjustment. While, innovations on the price-based nominal anchors (MRR and REER) have neutral and fleeting effects on output. He concludes that the manipulation of

quantity of money (M2) in the economy is the most influential instrument for monetary policy implementation.

Umar and Abdulhakeem (2010) employed a vector auto regressive (VAR) model to examine oil prices shocks and the Nigerian economy. The study was concerned with the effects of recent spikes in crude oil prices in Nigeria. They specified the model as;

$$Y_t = m + A_1Y_{t-1} + A_2Y_{t-2,} + \ldots, + A_pY_{t-p} + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2.16)$$

Where, A_i (i = 1, 2, …, p) = k × k matrix of coefficients, m = k × 1 vector of constants, U_t = vector of white noise process, Y_t = vector of endogenous variables which are real GDP, unemployment, CPI, money supply M_1, and crude oil prices. The results showed that oil prices have significant impact on real GDP, money supply and unemployment. Its impact on consumer price index was not significant. The study concluded that the Nigerian economy is vulnerable to external shocks which could be minimized via diversification of the economy.

Adam and Goderis (2006) examined the long history of fiscal mismanagement of oil boom in Nigeria. According to them, without the support of a disciplined and broadly predictable fiscal stance, Central Bank cannot make credible comments to an inflation target. They however believed that the successful consolidation of the financial sector in 2005 and the unification of the foreign exchange market in 2006 and measures such as the fiscal responsibility bill in the National Assembly have laid the foundation for improved fiscal management of oil revenue.

Akpan, (2009) examined oil price shocks and Nigeria's macro economy using VAR model for the period 1970 to 2007. He was also concerned about the effects of recent rise in crude oil prices on some macroeconomic variables. The study considered these variables; inflation rates derived from CPI, real oil prices deflated by United States' CPI, real public expenditures deflated by inflation rates, real effective exchange rates adjusted for inflation, the USA's CPI, real GDP proxied by real industrial production and crude oil prices. He specified the model as;

$$Y_t = A_1Y_{t-1} +, ..., + A_pY_{t-p} + \beta Z_t + U_t \quad \text{..... (2.17)}$$

Where, Y_t = vector of endogenous variables, Z_t = vector of exogenous variables, A_i and β = coefficients matrices, p = lag length. The result of the study suggests that oil prices significantly increase inflation and also directly increase real national income through higher export earnings. Furthermore, a positive relationship exists between oil price changes and real Government expenditures in Nigeria. He concluded that the Nigerian economy is vulnerable to oil price shocks and these shocks will be reduced if the Government diversify its revenue base and save the excess crude oil proceeds for future use of the economy.

Ayadi et al (2000) study the effects of oil production shocks for Nigeria as a net exporter of oil over the 1975-1992 periods. The study revealed the positive response of output after a positive oil production shock however, they notice that the response of inflation is negative after a positive oil production shock, to the extent that an oil price increase leads to an oil production increase. Therefore the response suggests that output increases, inflation decrease and the national currency depreciate following a positive oil price shock.

In a related study, Olomola and Adejumo (2006) employed the vector auto regression (VAR) method, using quarterly data from 1970 to 2003 to examine the effect of oil price shock on macroeconomic activity in Nigeria. They considered the following variables in the structural VAR model namely; real GDP proxied by index of industrial production (y), domestic price level measured by CPI, real exchange rates, and real oil prices. They also specify the following model;

$$Y_t = c + \sum \Phi_i Y_{t-1} + \varepsilon_t \quad \text{..... (2.18)}$$

Where, Y_t = n×1 vector of endogenous variables, $c = (c_1,....,c_5)$ is 5×1 intercept vector of VAR, Φ_i = is the i^{th} 5×5 matrix of auto regressive coefficients for I = 1,2,....,p and $\varepsilon_t = (\varepsilon_{it}, ...\varepsilon_{5t})$ the 5×1 generalization of white noise error process. The result of the study was contrary to previous

empirical findings in other countries. The result revealed that oil price shock does not affect output and inflation in Nigeria. However, oil price shocks do significantly influence the real exchange rates. They concluded that a high real oil price may give rise to wealth effect that appreciates the real exchange rate. This may squeeze the tradable sector, giving rise to the "Dutch Disease".

Aliyu (2009) used the VAR model to assess the impact of oil price shock and real exchange rate volatility on real economic growth in Nigeria using quarterly data from 1986Q1 to 2007Q4. He specified the model below

$$\Delta \mathbf{Y}_t = \alpha + \sum \beta_i \Delta \mathbf{Y}t_{-i} + \gamma \mathbf{Y}_{t-1} + \varepsilon_t \mathbf{Y}_t \quad \text{..... (2.19)}$$

Where, Y_t = vector of log of real GDP, log of oil price shocks and log of exchange rate volatility, α = 3×1 intercept vector, ε_t = vector of white noise error term, β_i = 3×3 matrix coefficients, γ = contained long run information on the data. The study found unidirectional causality from oil price to real GDP and bidirectional causality from real exchange rate to real GDP. Findings further show that oil price shock and appreciation in the level of exchange rate exert positive impact on real economic growth in Nigeria. They concludes that diversification of the economy through investment is key factor to promote the productive sectors of the economy to guard against the vicissitude of oil price shock and exchange rate volatility.

However studies in Nigeria such as Olusegun (2008) used ordinary least square method to examine crude oil and the Nigerian economic performance for the period 1970 to 2005. He transformed a Cobb-Douglass production function as follows;

$$\mathbf{RGDP} = \beta_0 + \beta_1 \mathbf{L} + \beta_2 \mathbf{K} + \beta_3 \mathbf{DC} + \beta_4 \mathbf{E} + \mathbf{U}_t \quad \text{..... (2.20)}$$

Where, U_t = stochastic or random error term, RGDP = GDP at factor price deflated by the CPI, L = labour inputs, K = capital inputs, DC = crude oil domestic consumption, and E = crude oil

exports, β_0 = intercept term, β_i = coefficients of the variables. The result of the study shows that crude oil consumption and exports have contributed to the improvement of the Nigerian economy. However, the study concluded that despite the positive effect of crude oil consumption and exports on real output, it has not significantly improved the growth of the economy.

2.5 Implication of Literature for the study

Most of the earlier studies concerning oil price shocks and volatility and economic activities have been conducted in the context of developed economies. Research concerning the impact of oil price volatility in the context of developing countries is very limited. Most developing countries less dependence on oil must have informed this. Therefore, very limited research has been conducted with reference to the developing countries. Although empirical literature abounds on the effect of crude oil price volatility on macro-economy, much of these studies focused on industrialized countries.

In Nigeria, empirical evidence on the impact of crude oil price volatility on monetary policy is also limited. Most of the studies in Nigeria focus on the impact of crude oil prices on real output, money supply and unemployment (Umar and Abdulkareem, 2010). However, Akpan (2009) focused on the impact of crude prices on inflation and Government spending. Olomola and Adejumo, (2006) focused on the impact of crude oil shocks on real exchange rates in Nigeria, while Aliyu, (2009) investigated the impact of crude oil shocks and exchange rates on real output in Nigeria. Other studies considered the impact of crude oil consumption and exports on real GDP in Nigeria (Olusegun, 2008). The studies failed to consider the effect of crude oil price volatility on monetary policy, net foreign asset, crude oil exports and imports in Nigeria. This implies that studying the impact of crude oil price shocks on monetary policy in Nigeria is

worth pursuing. This study is meant to bridge the gap in the literature as far as the impact of oil price volatility on monetary policy is concerned. The next chapter will explain how the study will bridge this gap.

CHAPTER THREE

METHODOLOGY

This chapter presents the research methodology. Immediately after the introduction, the theoretical/analytical framework, model specification, estimation procedures, sources of data, statement of hypothesis were discussed.

3.1 Theoretical/Analytical Framework

As noted earlier, monetary policy is usually designed to affect the quantity and price of financial assets used mainly for transactional, precautionary and speculative purposes. Expansion of aggregate money supply over and above the desired level (at a given cost or interest rate) may increase the demand for goods and services and thereby resulting to inflationary pressure (assuming the economy's output cannot be increased in the short run) or a loss of foreign exchange reserves or both. In the short run however, the effects of crude oil price shocks are related to the fact that crude oil is a basic input to production, and an increase in oil price leads to a rise in production costs that induces firms to lower output. Higher oil price causes an inward shift in short run aggregate supply and puts upward pressure on the general price level. Higher oil prices have a dampening effect on the rate of growth of real GDP and net foreign assets. This is because higher prices of oil reduce people's real incomes and their real purchasing power (Riley, 2006). And because firms are making less profit (due to higher production costs) this can lead to a reduction in planned capital investment. Since both consumption and investment are important components of aggregate demand, the result can be a slowdown in net foreign asset and growth leading to actual GDP falling below potential – i.e. a negative output gap (Riley, 2006). So, investigating the impact of crude oil price volatility on monetary policy is worth pursuing.

This study adopted the CBN's balance sheet approach (as the theoretical and analytical frameworks) presented in chapter two. From the monetary survey framework, it can be deduced that volatility in crude oil price may indirectly have impact on net foreign assets (NFA) and directly on money supply (M_2) in the economy.

$$\mathbf{M_2 = M_1 + Q_m = NDC + NFA + OAN} \quad \text{..... (3.1)}$$

In other words, net foreign assets and money supply are highly sensitive to fluctuations in crude oil prices. This is because Government budget, revenue and spending in Nigeria are highly dependent on crude oil sales revenue (Garba, 2003). Also, crude oil revenue account for about 95% of export earning and about 85% of Government revenue (Aliyu, 2009). From equation (3.1), net foreign asset is made up of capital account balance (KAB) and current account balance (CAB) in the balance of payment accounts. i.e.

$$\mathbf{NFA = CAB + KAB} \quad \text{..... (3.2)}$$

$$\mathbf{CAB = NFA - KAB} \quad \text{..... (3.3)}$$

According to Chuku, (2010). Oil price shocks have large and potentially harmful effects on external accounts (both for net oil importers and exporters), forcing countries to deplete their reserves and sometimes borrow from abroad to offset adverse terms-of-trade shocks and leading to the crowding-out of the tradable sector by means of exchange rate appreciation (Dutch disease) for net oil exporters. Therefore, current account balance is made up of the difference between total exports (X) and total imports (M) in Nigeria. i.e.

$$\mathbf{CAB = X - M} \quad \text{..... (3.4)}$$

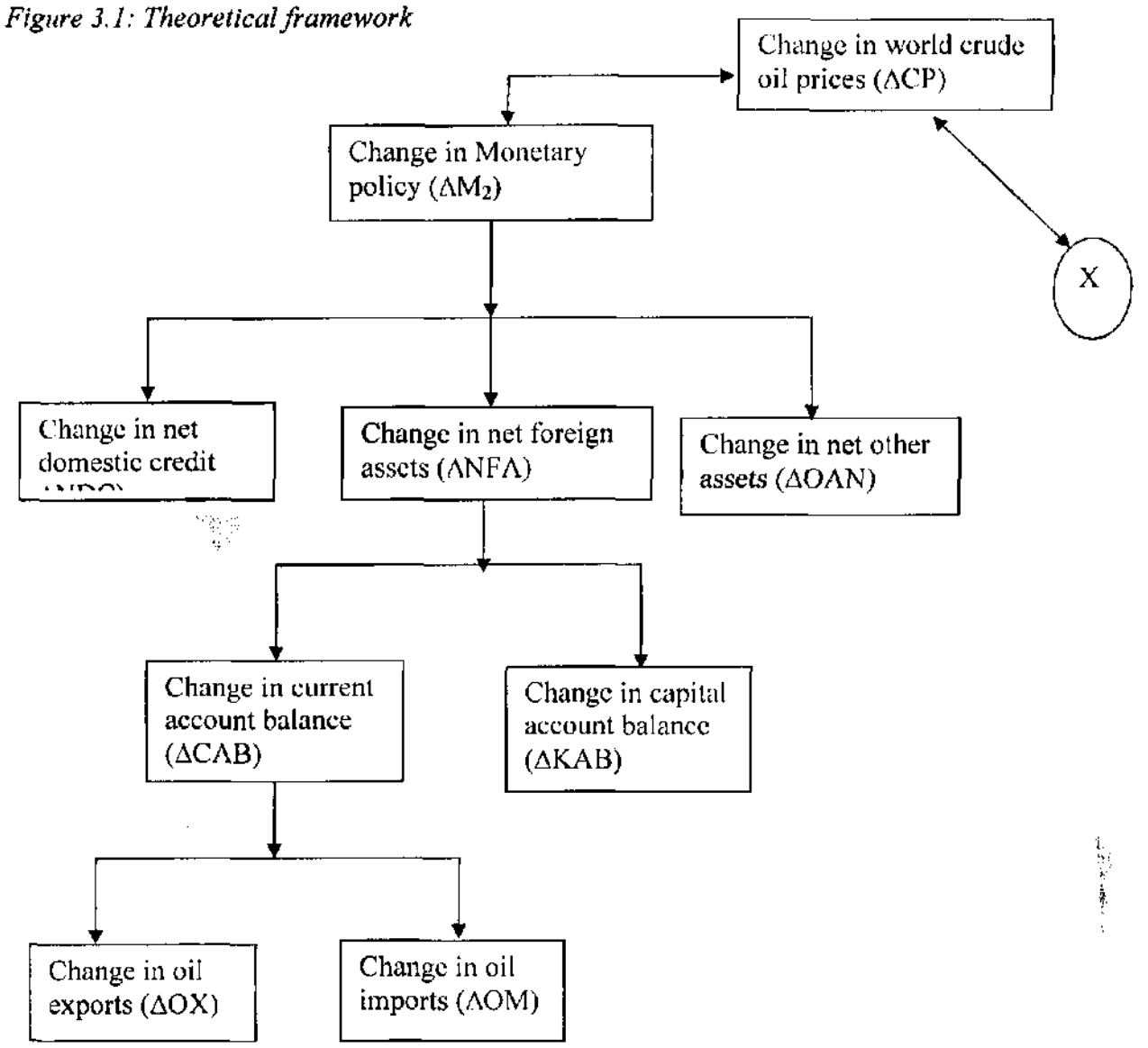
From equation (3.4), total exports consist of oil exports (OX) and non oil exports (NOX). While, total import is made of oil imports (OM) and non oil imports (NOM). i.e.

$$\mathbf{X = OX + NOX} \quad \text{..... (3.5)}$$

M = OM + NOM ..... (3.6)

The above discussion can be summarized in figure 3.1 below. Shocks in crude oil prices can bring about changes in the direction of monetary policy. The CBN may change the growth of money supply in order to reduce the effect of shocks on the domestic economy. A change in the growth rate of money supply also translates into change in net domestic credits (NDC), net foreign asset (NFA) and nets other assets (OAN). But shocks to crude oil prices can also affect monetary policy indirectly through changes in net foreign assets (NFA).

Figure 3.1: Theoretical framework



As a result of change in net foreign assets, the current account and capital account balances also change. The change in current account balance comes through changes in crude oil exports and imports. Crude oil exports rises as crude oil price rises, while crude oil imports rises as crude oil price falls. In figure 3.1, letter X represents other countries of the world that can also be affected in similar manner by changes in crude oil prices as in Nigeria.

Clearly, we can model the impact of crude oil price volatility on monetary policy by considering equations (3.1) and (3.2) as the foundation of the study. Other models (crude oil export and import models) can be generated using equation (3.5) and (3.6). The study made some modifications in the equations in order to accommodate other variables which could significantly influence money supply, net foreign asset, crude oil exports and crude oil import.

3.2. Empirical Framework

From the discussion above, we can directly analyze the impact of crude oil price volatility on monetary policy by modifying equation (3.1) and indirectly by modifying equation (3.2). For clarity of claims, we specified two additional models to justify the impact of crude oil price shocks on crude oil exports and imports. That is to say that four models are of interest in this study which includes monetary policy, net foreign asset, export and import of crude oil models. Before the models are specified, we discuss the operational measures of crude oil price volatility.

3.2.1 Measure of Crude Oil Price Volatility

It is well known that financial time series data such as prices of crude oil, stock prices, output level, fiscal deficits, and e.t.c. are characterized by a phenomenon known as volatility clustering, that is periods in which they exhibit wide swing for an extended time period followed by a period of relative calm, (Gujarati and Porter, 2009). One has to look at their behavior in the

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recent past. Apart from other measures of volatility discussed earlier, the autoregressive conditional heteroscedasticity (ARCH) and generalized autoregressive conditional heteroscedasticity (GARCH) models also model volatility or conditional variance of a random variable. The choice of ARCH and GARCH model is to analyze the risk of holding an asset or the value of an asset in the oil sector and to obtain more efficient estimators if hetroscedasticity in the error terms are properly managed. The general form of ARCH (1) process can be represented as GARCH (1, 0) model. i.e. the mean equation and the conditional variance equation are given as:

$$LCP_t = \alpha_0 + \varepsilon_t \quad \text{..... (3.19)}$$

$$\delta^2_t = c + \alpha\varepsilon^2_{t-1} \quad \text{..... (3.20)}$$

Where;

LCP_t = log of crude oil prices at time t (mean adjusted relative change in oil prices)
α_0 = intercept term of the mean equation
δ^2_t = conditional variance at time t
ε_t = error term of the mean equation at time t
ε^2_{t-1} = lagged value of squared error term

In equation (3.20), the error terms are conditionally normally distributed as $\varepsilon_t \sim N(0, \delta^2_t)$. According to Gujarati and Porter, (2009), if we square the residuals of the above regression, we obtain a measure of volatility. They further argued that being a squared quantity; its value will be high in periods of big changes in crude oil prices and comparatively low in periods of modest changes in crude oil prices. Note that if we used the variance of the regression (equation 3.19) above, it will be a single value for a given set of data. Therefore, we will use this crude oil price volatility measure to estimate the GARCH (1, 1) models specified below for the study.

3.2.1.1 Correlation Coefficient and Coefficient of Variation

The correlation coefficient measures the degree of relationship or association between two or more variables. The relationships could be positive or negative depending on the nature of the variables whether linear or non linear variables. The correlation coefficient is defined as

$$r_{XY} = \frac{\sum x_i y_i}{\sqrt{\sum x_i^2}\sqrt{\sum y_i^2}} \quad \text{..... (3.21)}$$

Where, $x_i = (X_i - \square)$, and $y_i = (Y_i - \square)$

However, the coefficient of variation can be computed and interpreted in two ways; analysing a single variable and interpreting a model. The single model will be computed by dividing the standard deviation of a variable by its mean. That is to say that the coefficient variation measures the size of standard deviation relative to the mean of the variable. Coefficient of variation has the advantage of standardising variability of a distribution by their mean. It is defined as;

Coefficient of variation = standard deviation/mean = s/□ ..... (3.22)

In modelling setting, the coefficient of variation is calculated as the ratio of root mean squared error (*RMSE*) to the mean of the dependable variable. In both methods, the coefficient of variation is often presented as a given ratio multiplied by 100. Therefore, the higher the coefficient of variation, the greater the variability in the variable.

3.2.1.2 Unit Root Tests

Most time series data have been found to be non-stationary which makes the usual regression results suffer from spurious regression problem. To evade this problem, we began the analysis with a prior investigation of the stationary properties of the time series using the Augmented Dickey-Fuller (ADF) test. The purpose of this was to get the level of integration of

the series. A series $\mathbf{Y_t}$ is said to be integrated of order **d** denoted by $\mathbf{Y_t \rightarrow I(d)}$ if it becomes stationary after differencing **d** times and thus $\mathbf{Y_t}$ contains **d** unit roots (Gujarati 2004). According to Greene (2003), the Augmented Dickey Fuller (ADF) test is employed to test for unit root based on an equation of the following forms;

$$Y_t = \alpha + \beta Y_{t-1} + \sum_{i=1}^{n} \beta_j \Delta Y_{t-i} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.23)$$

Equations (3.23) indicate ADF tests with intercept and without trend variable. Thus, the ADF unit root test posits a null hypothesis $\beta = 0$ versus an alternative hypothesis $\beta < 0$, where the ADF statistic was be compared with the observed Mackinnon critical values. If ADF statistic was greater than the Mackinnon critical values it implied the series had unit root.

3.2.1.3 The ARCH/GARCH Regression Model and ARCH LM Test

After unit root test, we will estimate the ARCH and GARCH models using e-views 4 and 7 versions. The ARCH and GARCH model was first used in 1982 by Engel and popularized as GARCH model in 1986 by Bollerslev. Therefore, most of the analytical tools in economics are designed to model the conditional mean of a random variable. The ARCH and GARCH models differ by modeling the conditional variance or volatility of a variable. The choice of ARCH and GARCH model is crucial because knowledge of volatility enables investors to make efficient and effective financial planning and investment decisions. The ARCH LM test is used to test for further ARCH effect in the residuals of the model. Since oil price is highly sensitive to shocks in the international market, we will model the equations following GARCH (1, 1) modeling pattern.

3.2.2 Impact of Crude Oil Price Volatility on Monetary Policy

Specification of Crude Oil Export Model

The crude oil export model is specified as a function of crude oil price volatility, output or quantity of crude oil produced, degree of trade openness, exchange rate, real output or income

and an autoregressive component of order one. The conditional variance equation is a function of the mean, (c), the ARCH term, and (ε^2_{t-1}) and the GARCH term, (δ^2_{t-1}). The sum of the ARCH and GARCH terms' parameters (i.e. $\alpha + \beta < 1$) are explaining the news about volatility from the previous period and the last periods forecast variance respectively. i.e.

$$\mathbf{OX_t = f\ (CPV_t, QCP_t, DOP_t, EXR_t, RGDP_t\ AR\ (1))} \quad \textbf{(3.13)}$$

We rewrite equation (3.13) as;

$$\mathbf{LOX_t = \alpha_0 + \alpha_1 LCPV_t + \alpha_2 LQCP_t + \alpha_3 LDOP_t + \alpha_4 LEXR_t + \alpha_5 LRGDP_t + \alpha_6 AR(1) + U_t} \quad \textbf{(3.14)}$$

The conditional variance of the model is given as;

$$\mathbf{\delta^2_t = c + \alpha\varepsilon^2_{t-1} + \beta\delta^2_{t-1}} \quad \textbf{(3.15)}$$

Where ;

L = natural logarithsm of numbers
CPV_t = crude oil price volatility
OX_t = crude oil export revenue at time t
QCP_t = output or quantity of crude oil produced at time t
DOP_t = degree of trade openness at time t (total GDP/total exports + total imports)
$RGDP_t$ = real Gross domestic product
EXR_t = exchange rate of the naira to US dollar at time t
MPR_t = monetary policy rate at time t
AR (1) = auto regressive process of order one
U_t = Random or error terms of the mean equation at time t
α_i (i = 1, 2, … 6) = elasticity coefficients of the variables
ε_t = error disturbance term of U_t at time t
c = the mean term
ε^2_{t-1} = the lag values of the squared residuals from the mean equation i.e. the ARCH term.
δ^2_{t-1} = last period forecast variance, i.e. the GARCH term.
δ^2_t = the conditional variance at time t. The variance of the error term which follows a normal distribution with zero mean and unit variance

In equation (3.14), α_1 is expected to be negative (i.e. $\alpha_1 < 0$) because crude oil exports reduce as crude oil price volatility increases. However, α_2, α_3, α_4, α_5 and α_6 are expected to be

positive (i.e. α_2, α_3, α_4, α_5 and $\alpha_6 > 0$) because oil exports increases as quantity of crude oil produced, degree of trade openness, exchange rates devaluation, and real GDP increases.

Specification of Net Foreign Asset Model

Similarly, we can say that net foreign assets in Nigeria depends on crude oil price volatility, money supply, real income (RGDP), exchange rate, foreign or external reserve, and an autoregressive component of order one i.e.

$$\mathbf{NFA_t = f\ (CPV_t, M_{1t}, RGDP_t, EXR_t, FR_t\ AR\ (1))} \quad \text{..... (3.10)}$$

Equation (3.10) is rewritten in log form and to capture the stochastic property of the model as;

$$\mathbf{LNFA_t = \alpha_0 + \alpha_1 LCPVt + \alpha_2 LM_{1t} + \alpha_3 LRGDP_t + \alpha_4 LEXR_t + \alpha_5 LFR_t + \alpha_6 AR(1) + U_t} \quad \text{..... (3.11)}$$

The conditional variance equation is as specified above. i.e. The conditional variance of the model is given as;

$$\mathbf{\delta^2_t = c + \alpha\varepsilon^2_{t-1} + \beta\delta^2_{t-1}} \quad \text{..... (3.12)}$$

Where;

NFA_t = net foreign asset at time t
FR_t = foreign or external reserve at time t
M_{1t} = narrow money supply

Also in equation (3.11), α_1 is expected to be negative (i.e. $\alpha_1 < 0$) because as crude oil prices become more volatile, net foreign asset reduces and vice versa. However, α_2 α_3 α_4 α_5 and α_6 are expected to be positive (i.e. α_2, α_3, α_4, α_5 and $\alpha_6 > 0$) because money supply, exchange rate, real output, and foreign reserve increases as net foreign asset increases. To further support the above model, we will also specify the export and import models for crude oil in Nigeria by also adopting equations (3.5) and (3.6).

Specification of Monetary Policy Model

Following the theoretical framework above, we can say that monetary policy proxied by money supply depends on crude oil price volatility, real income (real GDP), exchange rate, inflation, interest rate (proxied by monetary policy rate (MPR)) and an autoregressive component of order one. The conditional variance equation is a function of the mean, (c), the ARCH term, and (ε^2_{t-1}) and the GARCH term, (δ^2_{t-1}). The sum of the ARCH and GARCH terms' parameters (i.e. $\alpha + \beta < 1$) are explaining the news about volatility from the previous period and the last periods forecast variance respectively. i.e.

$$\mathbf{M_{2t} = f\ (CPV_t, RGDP_t, EXR_t, INF_t\ MPR_t\ AR(1))} \quad \text{..... (3.7)}$$

Equation (3.7) is rewriten in log form and to account for the stochastic property of the model as follows;

$$\mathbf{LM_{2t} = \beta_0 + \beta_1 LCPV_t + \beta_2 LRGDPt + \beta_3 LEXRt + \beta_4 LINF_t + \beta_5 LMPR_t + \beta_6 AR(1) + U_t} \quad \text{..... (3.8)}$$

The conditional variance of the model is given as;

$$\mathbf{\delta^2_t = c + \alpha\varepsilon^2_{t-1} + \beta\delta^2_{t-1}} \quad \text{..... (3.9)}$$

Where,

M_{2t} = broad money supply
INF_t = inflation rate at time t proxied by consumers' price index (CPI)
MPR_t = monetary policy rate at time t
AR (1) = auto regressive component of order one
U_t = Random or error terms of the mean equation at time t
β_i (i = 1, 2, ... 6) = elasticity coefficients of the variables
ε_t = error disturbance term of U_t at time t

In equation (3.8), β_1, β_4 and β_5 are expected to be negative (i.e. β_1, β_4 and $\beta_5 < 0$) because money supply reduces as crude oil price volatility, interest rates and inflation rates increases.

However, β_2, β_3 and β_6 are expected to be positive (i.e. β_2, β_3 and $\beta_6 > 0$) because real output and exchange rate devaluation increases as money supply increases.

The Crude Oil Import Model

The crude oil import model is a function of crude oil price volatility, quantity of crude oil produced, exchange rate; real GDP, foreign reserve and an autoregressive component of order one. That is to say that

$$OM_t = f\ (CPV_t, QCP_t, EXR_t, RGDP_t, FRt\ AR(1)) \quad \text{..... (3.16)}$$

We also rewrite equation (3.13) as;

$$LOM_t = \alpha_0 + \alpha_1 LCPV_t + \alpha_2 LQCP_t + \alpha_3 LEXR_t + \alpha_4 LRGDP_t + \alpha_5 LFR_t + \alpha_6 AR(1) + U_t \quad \text{..... (3.17)}$$

The conditional variance of the model is given as above;

$$\delta^2_t = c + \alpha\varepsilon^2_{t-1} + \beta\delta^2_{t-1} \quad \text{..... (3.18)}$$

In equation (3.17), α_1 and α_3 are expected to be negative (i.e. α_1 and $\alpha_3 < 0$) because crude oil imports reduce as crude oil price volatility and exchange rate devaluation increases. However, α_2, α_4, α_5 and α_6 are expected to be positive (i.e. α_2, α_4, α_5 and $\alpha_6 > 0$) because oil imports increases as quantity of crude oil produced, real GDP, and foreign reserves increases.

3.3 Sources of Data

The data used for this study covered the period 1980:1 to 2010:4. All data and information used were obtained from the CBN, National Bureau of Statistics (NBS), and the internet. Informational materials from the World Bank and IMF were utilized in the study. Therefore, the models specified indicates that we will need data on the following variables; broad money supply, net foreign asset, crude oil prices, output of crude oil, exchange rates, real

GDP, foreign reserves, inflation rates, CPI, degree of trade openness, crude oil exports, crude oil imports, and volume of trade in Nigeria.

3.4 Statement of Hypothesis

The hypothesis of this study is twofold and it is stated as follows;

H_0: $\beta_i = 0$; (i.e. Crude oil prices are not volatile).

H_1: $\beta_i \neq 0$; (i.e. Crude oil price are volatile).

H_0: $\alpha_i = 0$; (i.e Crude oil price volatility has no significant impact on monetary policy in Nigeria).

H_1: $\alpha_i \neq 0$; (i.e. Crude oil price volatility have significant impact on monetary policy in Nigeria).

Where; i = 1, 2, 3, 4, 5, and 6.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND INTERPRETATION OF RESULTS

In this chapter, we presented, analyzed and interpreted the results of the study. Immediately after the introduction, the first section measured crude oil price volatility and presented the estimates of correlation coefficients and coefficients of variation for the variables under investigation in section two. In the third section, we discussed the stochastic properties of the variables (unit root test) and estimated the models specified in section four. At the end of the chapter we presented the summary of major finding of the study.

4.1 Estimates of Crude Oil Price Volatilities

The estimated result of ARCH (1) model is presented below. The intercept term in the mean equation is the average percent rate of change in crude oil prices. Therefore, over the sample period, the average quarterly crude oil price change was about 1.3672%. The ARCH coefficient is significant at 5% level. This suggests that crude oil prices in Nigeria are volatile. The low coefficient of determination (R^2) was due to the fact that crude oil price was regressed on a constant and need not be interpreted.

LCP = 1.3672
Z-stat (233.93)
p-val [0.0000]

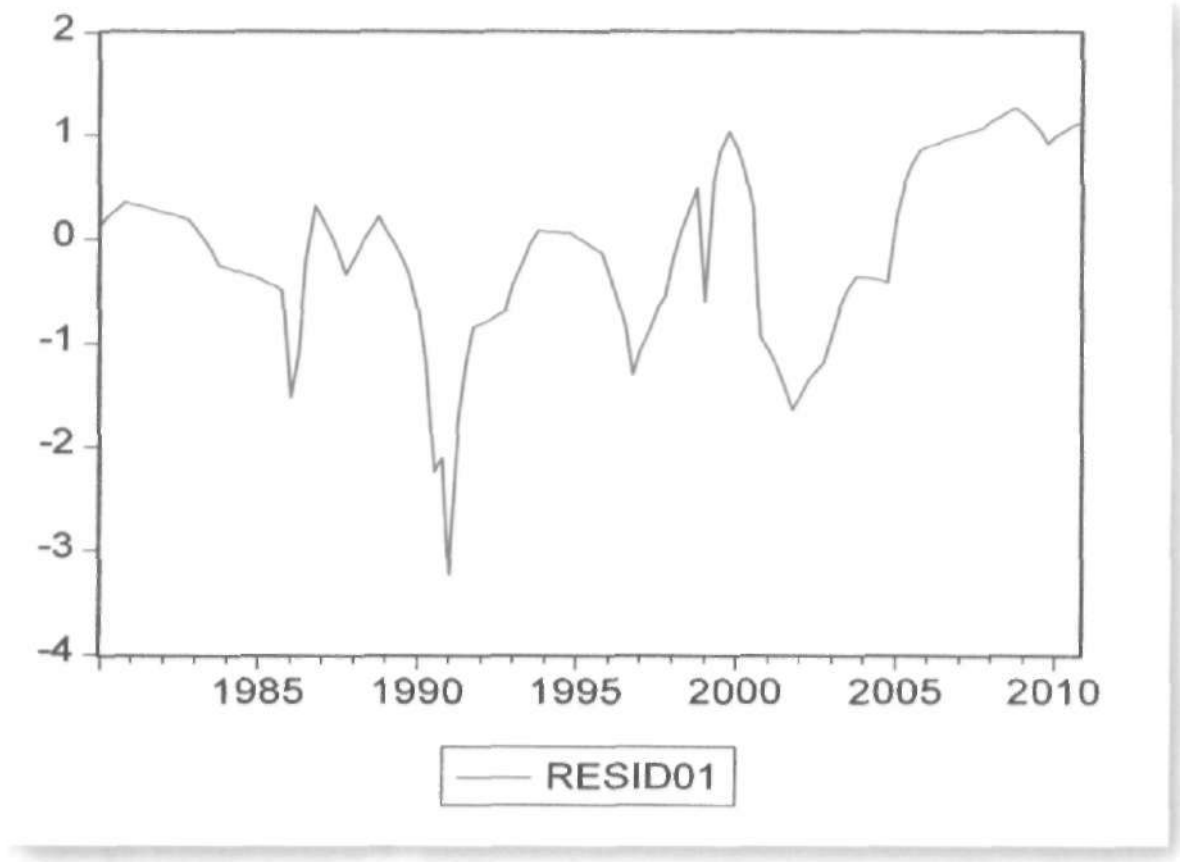
$$\delta^2_t = 0.00033 + 1.884\varepsilon^2_{t-1}$$
z-stat (0.4824) (4.1073)
p-val [0.6295] [0.0000]

R^2 = -0.1999, Adj. R^2 = -0.2198, D.W = 0.0411,

The error terms in the regression result above were squared and used as a measure of crude oil price volatility (LCPV). Figure 4.1 below shows the graph of the residuals obtained

from the regression above. The graph suggests also that the error terms are highly volatile. This is shown by the wave-like moments in periods of wide swing in the errors terms

Figure 4.1: Graph of residuals



In figure 4.2 and figure 4.3 below, the graph of squared residuals and its log were plotted and presented. The graph of log squared residual was more volatile and behaved in a similar manner as the real error terms' graph (figure 4.1). The volatility in crude oil prices was spiky and moved downward during the oil glut period of late 1980s to early 1990s. By late 1990s, oil price volatility had gone upward and became spikier between 1997 and 2000 when the world

experienced mild recession. From 2003 to date, crude oil prices have averagely taken upward trends which are shown by the movements in the volatility graphs.

Figure 4.2: Graph of squared residuals

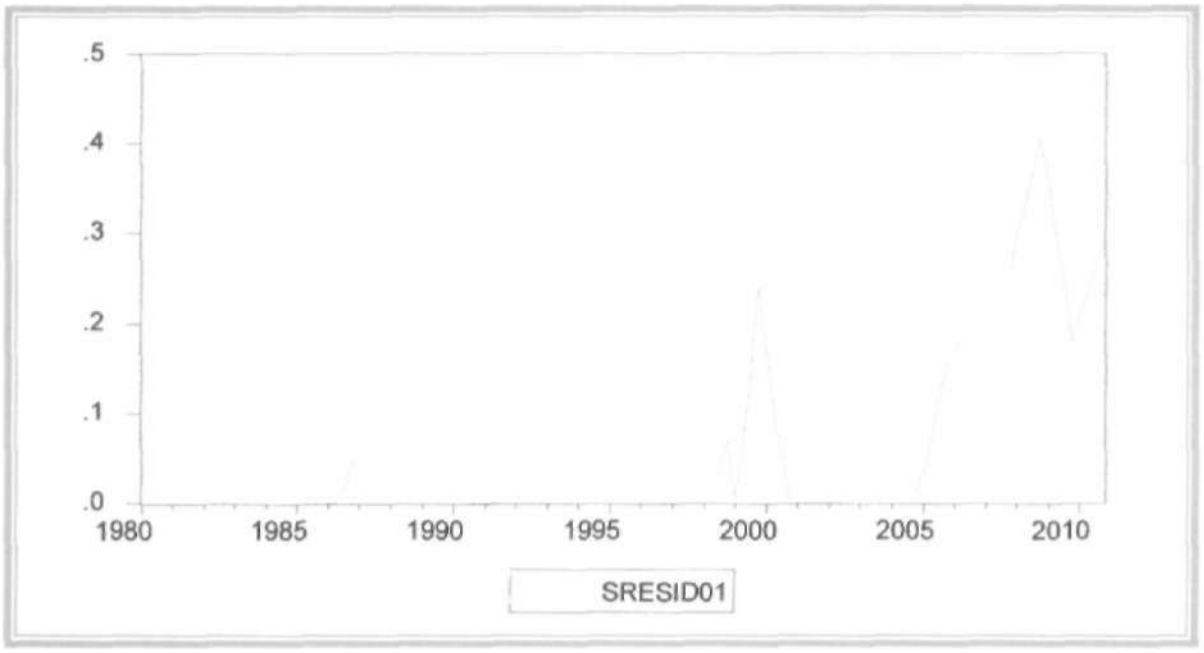
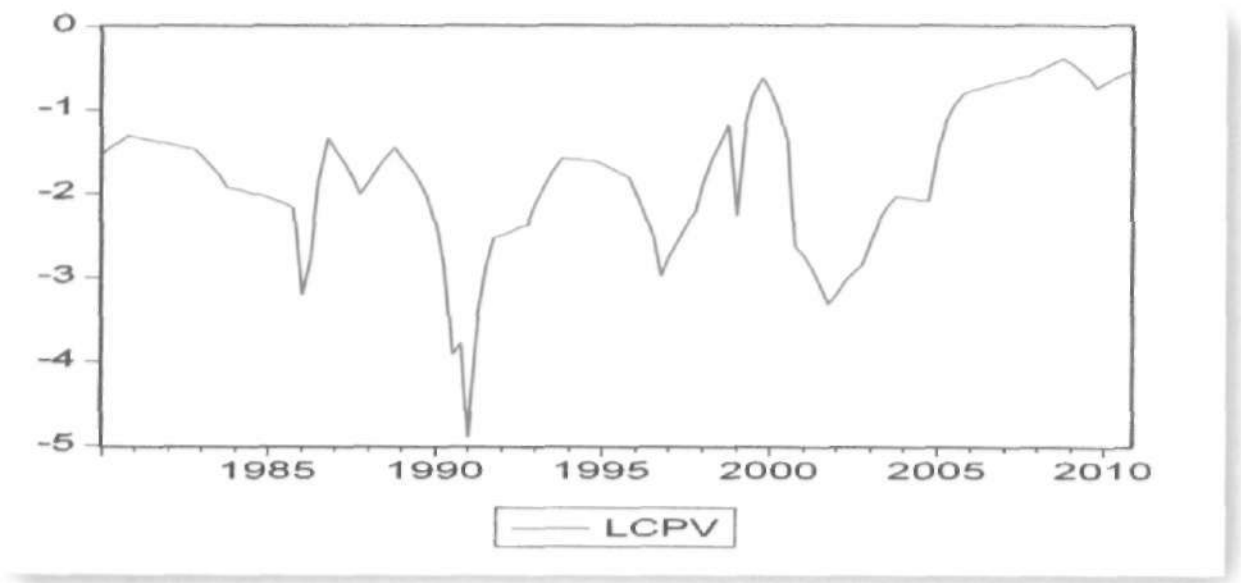


Figure 4.3: Graph of log of squared residuals



4.1.1 Estimates of Correlation Coefficients and Coefficients of Variation

The table below shows the correlation coefficients of each model specified in chapter three. In the money supply (LM_{2t}) model, all the variables have positive coefficients. This means that crude oil price volatility ($LCPV_t$), real GDP, exchange rates ($LEXR_t$), inflation ($LINF_t$), and monetary policy rates ($LMPR_t$) increase or decrease together with money supply. The degree of co-variability between these variables is highest (97.64%) for inflation and lowest (17.21%) for monetary policy rate. Notice that a negative relationship exists between degree of trade openness and crude oil exports.

Table 4.1: Summary of correlation coefficients estimates

Model	$LCPV_t$	$LRGDP_t$	$LEXR_t$	$LINF_t$	$LMPR_t$	LFR_t	$LQCP_t$	$LDOP_t$	LM_{2t}
LM_{2t}	0.3506	0.8254	0.7264	0.9764	0.1721	-	-	-	-
$LNFA_t$	0.2853	0.7464	0.7601	-	-	0.8595	-	-	0.9691
LOX_t	0.2778	0.7686	0.7551	-	-	-	0.7946	-0.4825	-
LOM_t	0.2452	0.7571	0.7755	-	-	0.7868	0.7624	-	-

However, crude oil price volatility co-vary positively with money supply, net foreign asset ($LNFA_t$), crude oil exports (LOX_t), and crude oil imports (LOM_t) by 35.06%, 28.53%, 27.78% and 24.52% respectively. Note that the degree of association was highest in the money supply model, followed by the net foreign asset model. According to Koutsoyiannis, (1979), 'although the correlation coefficient is a measure of co-variability of variables, it does not necessarily imply any functional relationship between the variables concerned. Correlation coefficient does not establish and prove any causal relationship between the variables.' If the assertion above is correct, then it becomes necessary for us to investigate further via statistical method. One of the techniques used in this study is the coefficient of variation to examine the variability between the variables under consideration.

The coefficients of variation presented in table 4.2 below allows for comparism of variability of variables regardless of the magnitude and unit of measurement of the distribution. It also shows the consistency of sample distribution in terms of uniformity in the values of the data or distribution. The coefficient of variation for crude oil price volatility (LCPV) is -2.125, meaning that the sample distribution is volatile and has low variance. It also implies that the variability in the $LCPV_t$ sample distribution is about -212.5%. However, when compared to other variables, the extent of variation is highest in output of crude oil production (LQCP) of 3,490.1% in Nigeria. If plotted on a graph, the crude oil output movements followed the trends in the world crude oil prices.

Table 4.2: Summary of coefficients of variation estimates

Variable	Mean	Standard deviation	Coefficient of variation
LM_{2t}	5.443	0.938	5.803
$LNFA_t$	5.015	1.359	3.690
LOX_t	5.493	1.094	5.021
LOM_t	4.415	1.369	3.225
$LCPV_t$	-1.779	0.837	-2.125
$LRGDP_t$	4.896	0.309	15.845
$LEXR_t$	1.312	1.063	1.234
$LINF_t$	0.959	0.808	1.187
$LMPR_t$	1.082	0.162	6.679
$LQCP_t$	2.827	0.081	34.901
LFR_t	3.753	0.554	6.774
$LDOP_t$	-0.299	0.185	-1.616
CPV_t	0.063	0.097	1.537

Therefore, going by the crude oil price volatility model above, the coefficient of variation in crude oil price volatility model is 15.65% (given that the standard deviation is 0.230001 and mean of the dependent variable is 1.469598; see appendix A). Since most of the variables under consideration are highly volatile by this descriptive evidence, we can conclude that crude oil prices are volatile. This is because both the ARCH (1), graph of squared error terms and the

coefficient of variation estimates have provided evidences that crude oil prices are volatile. This does not mean to say that the analysis so far is sufficient to establish functional relationships between the variables. The study estimated the specified models using GARCH (1, 1) model.

4.1.2 Unit Root Test Results

The table below shows the unit root results of variables under consideration. The ADF type of unit root was conducted on all the variables at constant or intercept. The reason was to overcome the problem of spurious regression often associated with time series data. The result of the test suggests that all the variables are integrated of order one (i.e. I (1)). The order of integration indicates the number of times a variable will be differenced. This means that all the variables will be differenced once to arrive at stationarity. Since the entire ADF statistic is greater than the Mackinnon critical values at 5% level of significance, we therefore reject the hypothesis of unit root in all the variables.

Table 4.3: ADF unit root results

Variable	ADF Statistic	Nuisance Factor	Levels of significance 1%	5%*	10%	Order of integration
LCP_t	-5.3368	C	-3.4865	-2.8859	-2.5796	I (1)
LM_{2t}	-4.2799	C	-3.4865	-2.8859	-2.5796	I (1)
$LRGDP_t$	-5.9398	C	-3.4865	-2.8859	-2.5796	I (1)
$LCPV_t$	-5.1674	C	-3.4865	-2.8859	-2.5796	I (1)
$LEXR_t$	-5.9815	C	-3.4865	-2.8859	-2.5796	I (1)
$LINF_t$	-4.1224	C	-3.4865	-2.8859	-2.5796	I (1)
$LMPR_t$	-5.4594	C	-3.4865	-2.8859	-2.5796	I (1)
$LNFA_t$	-4.1431	C	-3.4865	-2.8859	-2.5796	I (1)
LFR_t	-4.3178	C	-3.4865	-2.8859	-2.5796	I (1)
LOX_t	-4.8749	C	-3.4865	-2.8859	-2.5796	I (1)
LOM_t	-5.0299	C	-3.4900	-2.8874	-2.5804	I (1)
$LQCP_t$	-4.4809	C	-3.4865	-2.8859	-2.5796	I (1)
$LDOP_t$	-6.9800	C	-3.4865	-2.8859	-2.5796	I (1)

Note: C = constant; TC = trend and intercept; N = none
** = criteria for rejection of hypothesis of unit root.*

4.2 Impact Analysis

The Crude Oil Export Model

The study used the crude oil export model to further validate the claims above. This is to make sure that crude oil price volatility is also responsive to changes in crude oil export in Nigeria. The coefficient of determination, R^2 of 0.9947 also means that about 99.43% of the variations in crude oil export is explain by variations in the explanatory variables. The F-statistics of 2363.82 suggests that the overall model is significant at 5% percent level of significance. The Durbin Watson (D.W.) statistics of 1.9770 is within the acceptable range that indicates absence of serial correlation in the residuals. The results of the export model are presented below and in appendix D.

$$\mathbf{Lox_t = -38.88 - 0.024lcpv_t + 0.782lqcp_t - 0.016ldop_t - 0.0403lexr_t - 0.0078lrgdp_t + 1.0004AR(1)}$$

(z-stat)	**(-0.274)**	**(7.006)**	**(5.708)**	**(-0.447)**	**(-11.483)**	**(-0.1516)**	**(698.42)**
[p-val]	**[0.784]**	**[0.000]**	**[0.000]**	**[0.655]**	**[0.000]**	**[0.880]**	**[0.000]**

$$\mathbf{\delta^2_t = 3.44 + 0.829\varepsilon^2_{t-1} + 0.511\delta^2_{t-1}}$$

(z-stat)	**(1.399)**	**(5.969)**	**(17.895)**
[p-val]	**[0.162]**	**[0.000]**	**[0.000]**

R^2 = 0.9947; Adj. R^2 = 9943; D.W. = 1.9769; F-stat. = 2363.82; Prob(F-stat.) = 0.00000

The coefficients of crude oil price volatility and output of crude oil production met the a-priori expectation and are also significant at 5% level of significance. The result above also shows that all the coefficients of the explanatory variables are inelastic meaning that crude oil export is less responsive to changes in crude oil price volatility, output of crude oil production, degree of trade openness, exchange rate, and real output. This means that when crude oil price volatility increase by one percent, crude oil export will decrease by 0.024 percentage points. The finding also suggests that crude oil price volatility has a significant negative impact on crude oil

export in Nigeria. More so, if crude oil output increases by one percent, crude oil export will increase by 0.782 percentage points. The coefficient of exchange rate is significant at 5% level but does not meet the a-priori expectation of the model. However, the coefficients of degree of trade openness and real output did not meet the a-priori expectations and are also insignificant in influencing crude oil export in Nigeria.

The coefficients of ARCH and GARCH terms are significant at 5% level of significance. The high value of ARCH term (0.8290) means that volatility reacts intensely to crude oil export movements. However, the value of GARCH term (0.5106) means that shocks to conditional variance takes long time to die out so that volatility is highly persistent. The sum of ARCH and GARCH terms (i.e 0.8290 + 0.5106) is 1.3396 which means that the model has an infinite variance and volatility is persistent. This also means that crude oil price volatility has been part of distortions to crude oil export in Nigeria.

ARCH LM Test:

F-statistic	0.504270	Probability	0.479007
Obs*R-squared	0.510530	Probability	0.474910

The ARCH LM test above accepts the null hypothesis of no ARCH effects in the residuals of the crude oil export model.

The Net Foreign Asset Model

One of the central arguments in this study is that shocks in crude oil prices can reduce or increase the country's net foreign assets and this will in turn have impact on the direction of monetary policy in Nigeria. The study therefore used net foreign assets to analyze the indirect impact of crude oil price volatility on monetary policy in Nigeria. The empirical results below support the above arguments. The coefficient of determination, R^2 of 0.9892 means that about 98.92% of the variations in net foreign asset is explain by variations in the explanatory variables.

The F-statistics of 1128.42 suggests that the overall model is significant at 5% percent level of significance. The Durbin Watson (D.W.) statistics of 2.0208 is within the acceptable range that indicates absence of serial correlation in the residuals.

$$\mathbf{Lnfa_t = 4.024 - 0.069lcpv_t + 0.367lm_{1t} - 0.070lrgdp_{t-1} + 0.035lexr_t + 0.141lfr_{t-2} + 0.980AR(1)}$$

(z-stat)	**(4.194)**	**(-2.233)**	**(3.028)**	**(-1.268)**	**(3.356)**	**(1.901)**	**(110.82)**
[p-val]	**[0.000]**	**[0.026]**	**[0.003]**	**[0.205]**	**[0.001]**	**[0.047]**	**[0.000]**

$$\mathbf{\delta^2_t = -8.76 + 0.188\varepsilon^2_{t-1} + 0.826\delta^2_{t-1}}$$

(z-stat)	**(-2.162)**	**(2.950)**	**(20.000)**
[p-val]	**[0.031]**	**[0.003]**	**[0.000]**

R^2 = 0.9892; Adj. R^2 = 9883; D.W. = 2.0208; F-stat. = 1128.42; Prob (F-stat.) = 0.00000

The coefficient of crude oil price volatility, money supply, exchange rate, two quarter lagged period of foreign reserve and the autoregressive component met the a-priori expectation and is also significant at 5% level of significance. All the coefficients of the explanatory variables are inelastic suggesting that net foreign asset is less responsive to changes in crude oil price volatility, money supply, real output, exchange rate and lagged foreign reserves. For crude oil price volatility, a one percent increase or decrease in crude oil price volatility will results to a 0.069 percentage points decrease or increase in the country's net foreign assets. This also means that crude oil price volatility has a significant negative impact on net foreign assets in Nigeria. Similarly, the coefficient of narrow money supply met the a-priori expectation and also significant in influencing net foreign assets in Nigeria. The broad money supply did not perform better. This finding is consistent with the direct effect model (i.e. the monetary policy model). However, the impact of real output coefficient is not in the right direction and also significant at 5% level.

The coefficients of ARCH and GARCH terms are significant at 5% level of significance. The low value of ARCH term (0.188) means that volatility reacts slowly to net foreign asset movements. However, the high value of GARCH term (0.826) means that shocks to conditional variance takes long time to die out so that volatility is highly persistent. The sum of ARCH and GARCH terms (i.e 0.188 + 0.826) is 1.0140 which means that the model has an infinite variance and volatility is highly persistent. This also means that crude oil price volatility has been part of the reasons for distortions and instability to net foreign asset in Nigeria

ARCH LM Test:			
F-statistic	1.149730	Probability	0.285775
Obs*R-squared	1.157867	Probability	0.281908

The ARCH LM test above accepts the null hypothesis of no ARCH effects in the residuals of the model.

The Monetary Policy Model

In the results below, the R^2 of 0.9992 means that about 99.92% of the variations in monetary policy (money supply) are explained by variations in the explanatory variables. The F-statistics of 14656.5 suggests that the overall model is significant at 5% percent level of significance. The Durbin Watson (D.W.) statistics is within the acceptable range that indicates absence of auto correlation in the residuals. Detail of the results is presented in appendix D below.

$$\mathbf{Lm_{2t} = 1.499 - 0.016lcpv_{t-1} + 0.085lrgdp_{t-3} - 0.0001lexr_t + 0.243linf_t - 0.164lmpr_{t-1} + 1.005AR(1)}$$

(z-stat)	**(0.630)**	**(-2.783)**	**(3.592)**	**(-0.063)**	**(3.816)**	**(-2.682)**	**(264.73)**
[p-val]	**[0.529]**	**[0.005]**	**[0.000]**	**[0.950]**	**[0.000]**	**[0.007]**	**[0.000]**

$$\mathbf{\delta^2_t = 1.76 - 0.075\varepsilon^2_{t-1} + 1.061\delta^2_{t-1}}$$

(z-stat)	**(2.189)**	**(-2.288)**	**(28.891)**
[p-val]	**[0.028]**	**[0.022]**	**[0.000]**

R^2 = 0.9992; Adj. R^2 = 9991; D.W. = 2.1250; F-stat. = 14656.53; Prob (F-stat.) = 0.00000

The results also show that the coefficients of crude oil price volatility, real output and interest rate meet the a-priori expectations and are statistically significant at 5% level. The coefficients are all inelastic meaning that monetary policy is less responsive to changes in crude oil price volatility, real output, exchange rate, inflation and interest rates in Nigeria. For instance, when crude oil price volatility increases or reduces by one percent in the last quarter, current money supply will reduce or increase by 0.016 percentage points. That is to say that past quarter shocks in crude oil price has a significant negative impact on current monetary policy in Nigeria. However, the coefficient of exchange rate does not meet the a-priori expectation and also insignificant in influencing monetary policy in Nigeria. Similarly, the coefficient of inflation does not meet the a-priori expectation but has a significant positive impact on monetary policy in Nigeria. The autoregressive component is significant which shows that the model is in place.

The coefficients of ARCH and GARCH terms are significant at 5% level of significance. The low ARCH term (-0.0753) means that volatility react slowly to money supply movements. However, the high value of GARCH term (1.0605) means that shocks to conditional variance take long time to die out. The sum of ARCH and GARCH terms (i.e -0.0753 + 1.0605) is 0.9852 which means that volatility is persistent. This also means that crude oil price volatility has been part of reason for the distortions and instability to monetary policy in Nigeria.

ARCH LM Test:

F-statistic	0.579521	Probability	0.448032
Obs*R-squared	0.586522	Probability	0.443767

The result of ARCH LM test above suggests that we accept the null hypothesis of no further ARCH effect in the residuals of the regression.

The Crude Oil Import Model

The result below shows that the coefficient of crude oil price volatility met the a-priori expectation and is also insignificant at 5% level of significance. The coefficient is also inelastic meaning that crude oil import is less responsive to changes in crude oil price volatility. This means that crude oil price volatility has an insignificant impact on crude oil import in Nigeria. The coefficient of exchange rate did not meet the a-priori expectation but significant at 5% level of significance. The coefficients of crude oil output, real output and foreign reserve met the a-priori expectations and are also significant at 5% level.

$$\mathbf{Lom = -22.604 - 0.041lcpv_t + 6.012lqcp_{t-1} + 0.215lexr + 1.645lrgdp_t + 0.396lfr + 0.892AR(1)}$$

(z-stat)	**(-3.893)**	**(-0.431)**	**(3.003)**	**(7.830)**	**(8.608)**	**(3.039)**	**(12.861)**
[p-val]	**[0.000]**	**[0.667]**	**[0.003]**	**[0.000]**	**[0.000]**	**[0.002]**	**[0.000]**

$$\mathbf{\delta^2_t = 0.032 - 0.038\varepsilon^2_{t-1} + 0.472\delta^2_{t-1}}$$

(z-stat)	**(3.230)**	**(-1.405)**	**(4.607)**
[p-val]	**[0.001]**	**[0.160]**	**[0.000]**

$R^2 = 0.9733$; Adj. $R^2 = 9712$; D.W. = 1.5323; F-stat. = 453.97; Prob(F-stat.) = 0.00000

The coefficient of determination, R^2 of 0.9733 also means that about 97.33% of the variations in crude oil import is explain by variations in the explanatory variables. The F-statistics of 453.97 suggests that the overall model is significant at 5% percent level of significance. The Durbin Watson (D.W.) statistics of 1.5323 is within the acceptable range that indicates absence of serial correlation in the residuals.

The result also shows that the coefficient of ARCH term is insignificant, while the GARCH term is significant at 5% level of significance. The low value of ARCH term (-0.0381) means that volatility react slowly to crude oil import movements. However, the value of GARCH term (0.4723) means that shocks to conditional variance take short time to die out so that

volatility is not persistent. The sum of ARCH and GARCH terms (i.e -0.0381 + 0.4723) is 0.4342 which means that volatility is not persistent. This also means that crude oil price volatility has been able to reduce the distortions to crude oil import in Nigeria.

ARCH LM Test:

F-statistic	0.193817	Probability	0.660557
Obs*R-squared	0.196754	Probability	0.657354

The ARCH LM test above also accepts the null hypothesis of no ARCH effects in the residuals of the crude oil import model.

4.3 Summary of Findings

From the discussion so far, the study has summarized the major findings below;

- The study showed that crude oil prices are volatile over the sample period studied.
- The correlation coefficients revealed that crude oil price volatility has a positive relationship with money supply, net foreign assets, crude oil export and crude oil import in Nigeria.
- The coefficient of variation for crude oil price volatility provided further evidence of volatility and low variance property of the crude oil price distribution.
- The unit root test result showed that the variables are integrated of order one and are differenced once to arrive at stationarity.
- The crude oil export model also showed that the coefficient of crude oil volatility is inelastic and has a significant negative impact on crude oil export in Nigeria. The sum of ARCH and GARCH terms suggests that the error terms have an infinite variance and volatility is persistent. This also means that crude oil price volatility has been part of distortions to crude oil export in Nigeria.

- The net foreign asset and monetary policy models showed that the coefficient of crude oil price volatility is inelastic and has a significant negative impact on net foreign asset and money supply respectively in Nigeria. The sum of ARCH and GARCH terms in the two models showed that volatility is persistent. This means that crude oil price volatility have been part of the distortions and instability in net foreign asset and monetary policy in Nigeria. There are further evidences that real output and inflation exerted significant positive impact on monetary policy in Nigeria.
- The crude oil import model showed that crude oil price volatility coefficient is inelastic and has an insignificant negative impact on crude oil import in Nigeria. The sum of ARCH and GARCH terms suggests that volatility is not persistent. This also means that crude oil price volatility has been able to reduce the distortions to crude oil import in Nigeria.
- The conduct of ARCH LM test also accepts the null hypothesis of no further ARCH effects in the residuals of all the models under study.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the Study

The study analyzed the impact of crude oil price volatility on monetary policy in Nigeria for the period 1980:1 to 2010:4. The study was carried out with two main objectives. The first objective was to estimate the extent of crude oil price volatility. And the second objective was to analyze the impact of crude oil price volatility on monetary policy in Nigeria. The literature review revealed that crude oil price can be affected by demand and supply side shocks in the market. And these shocks can constrain the effectiveness of monetary policy in Nigeria. As a result, monetary policy in Nigeria has undergone series of transformation from one era to another in a bid to maintain monetary stability in the economy. Past research have centered on the impact of oil price shocks on some macroeconomic variables in Nigeria.

The study therefore used ARCH and GARCH method to analyze the data collected. The result of the study shows that crude oil prices are volatile over the period studied. The correlation coefficients revealed that crude oil price volatility has a positive relationship with money supply, net foreign assets, crude oil exports and crude oil imports in Nigeria. The coefficient of variation for crude oil price volatility provided further evidence of volatility and low variance property of the crude oil price distribution. The unit root test result showed that the variables are integrated of order one and are differenced once to arrive at stationarity. Furthermore, the monetary policy and net foreign asset models showed that the coefficient of crude oil price volatility is inelastic and has a significant negative impact on money supply and net foreign asset respectively in Nigeria. The sum of ARCH and GARCH terms in the two models showed that volatility is

persistent. There are further evidences that real output and inflation exerted significant positive impact on monetary policy in Nigeria.

The crude oil export model also showed that the coefficient of crude oil volatility is inelastic and has a significant negative impact on crude oil export in Nigeria. The sum of ARCH and GARCH terms suggests that the error terms have an infinite variance and volatility is persistent. The crude oil import model showed that crude oil price volatility coefficient is inelastic and has an insignificant negative impact on crude oil import in Nigeria. The sum of ARCH and GARCH terms suggests that volatility is not persistent. The conduct of ARCH LM test also accepts the null hypothesis of no further ARCH effects in the residuals of all the models under study.

5.2 Conclusion of the Study

The findings of the study suggest that crude oil price volatility definitely have significant impact on monetary policy, net foreign assets, and crude oil exports. However, the impact of crude oil price volatility on crude oil import was insignificant. The implication of this finding is that Government budget, revenue and spending are also highly sensitive to crude oil revenue generation in Nigeria. Further depreciation of the Naira will increase the country's exports earning and hence an increase in Government revenue. However, import bills on crude oil will reduce it. These points to the fact that the economy should be diversify to enhance the performance of monetary policy in Nigeria. Diversifying the economy will reduced downward shocks coming from crude oil price fluctuations. However, the current surge in crude oil prices hold great potentials for an improvement in monetary policy performance in Nigeria.

5.3 Recommendations of the Study

The study therefore recommends the following measures based on the findings.

- Monetary policy should be geared towards diversifying the Nigerian economy. It should be done in such a way that over dependence on crude oil alone as a major source of export revenue will be reduced.
- The Government and the CBN should encouraged real productive activities in the economy. This can be done by promoting investments in manufacturing, mining and extraction of solid minerals, oil and gas, and real services.
- The CBN should ensure that the external reserve is managed creatively and productively in manner that will attract foreign investors into the country.
- Since crude oil price volatility is inelastic, there are further incentives for the Government to utilize the rising oil prices and generate more revenue for its developmental programmes
- The recent petroleum industry bill is a step in the right direction because it will encourage private individuals and enhance private sector's participation in the oil sector.
- Further research should be geared towards investigating the impact of crude oil price volatility on Government fiscal operations in Nigeria. The use of high frequency data will very meaningful.

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APPENDICES

Appendix A: Estimates of crude oil volatility

Dependent Variable: LCP
Method: ML - ARCH (Marquardt)
Date: 12/20/11 Time: 05:41
Sample: 1980:1 2010:4
Included observations: 124
Convergence achieved after 53 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
C	1.367170	0.005844	233.9302	0.0000
Variance Equation				
C	0.000326	0.000676	0.482402	0.6295
ARCH(1)	1.188379	0.289335	4.107280	0.0000

R-squared	-0.199941	Mean dependent var	1.469598
Adjusted R-squared	-0.219774	S.D. dependent var	0.230001
S.E. of regression	0.254020	Akaike info criterion	-0.962024
Sum squared resid	7.807691	Schwarz criterion	-0.893791
Log likelihood	62.64549	Durbin-Watson stat	0.041144

Appendix B: Estimates of correlation coefficients

	LM2	LCPV	LRGDP	LEXR	LCPI	LMPR
LM2	1.000000	0.350585	0.825367	0.728692	0.976487	0.172069
LCPV	0.350585	1.000000	0.301543	0.084350	0.267137	-0.505824
LRGDP	0.825367	0.301543	1.000000	0.590875	0.753802	0.070002
LEXR	0.728692	0.084350	0.590875	1.000000	0.746353	0.435113
LCPI	0.976487	0.267137	0.753802	0.746353	1.000000	0.304207
LMPR	0.172069	-0.505824	0.070002	0.435113	0.304207	1.000000

	LNFA	LCPV	LM2	LRGDP	LEXR	LFR
LNFA	1.000000	0.285344	0.969079	0.746402	0.760135	0.859546
LCPV	0.285344	1.000000	0.350585	0.301543	0.084350	0.461183
LM2	0.969079	0.350585	1.000000	0.825367	0.728692	0.827687
LRGDP	0.746402	0.301543	0.825367	1.000000	0.590875	0.645190
LEXR	0.760135	0.084350	0.728692	0.590875	1.000000	0.555027
LFR	0.859546	0.461183	0.827687	0.645190	0.555027	1.000000

	LOX	LCPV	LQCP	LDOP	LEXR	LRGDP
LOX	1.000000	0.277797	0.794620	-0.482485	0.755096	0.768621
LCPV	0.277797	1.000000	0.149866	-0.066388	0.084350	0.301543
LQCP	0.794620	0.149866	1.000000	-0.487853	0.624774	0.364108
LDOP	-0.482485	-0.066388	-0.487853	1.000000	-0.363078	-0.262107
LEXR	0.755096	0.084350	0.624774	-0.363078	1.000000	0.590875
LRGDP	0.768621	0.301543	0.364108	-0.262107	0.590875	1.000000

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	LOM	LCPV	LQCP	LEXR	LRGDP	LFR
LOM	1.000000	0.245183	0.762373	0.775521	0.757076	0.786778
LCPV	0.245183	1.000000	0.149866	0.084350	0.301543	0.461183
LQCP	0.762373	0.149866	1.000000	0.624774	0.364108	0.680027
LEXR	0.775521	0.084350	0.624774	1.000000	0.590875	0.555027
LRGDP	0.757076	0.301543	0.364108	0.590875	1.000000	0.645190
LFR	0.786778	0.461183	0.680027	0.555027	0.645190	1.000000

Estimates of Descriptive Statistics

	LM2	LNFA	LOX	LOM	LCPV	LRGDP	LEXR	LCPI	LMPR	LQCP	LFR	LDOP
Mean	5.443	5.015	5.493	4.415	-1.779	4.896	1.312	0.959	1.082	2.827	3.753	-0.299
Median	5.472	5.041	5.846	5.051	-1.720	4.850	1.340	1.293	1.130	2.846	3.744	-0.322
Maximum	7.060	6.931	7.027	6.317	-0.391	5.925	5.289	2.057	1.359	2.963	4.784	0.091
Minimum	4.057	2.700	3.857	1.714	-4.898	3.868	-0.272	-0.360	0.720	2.654	2.408	-1.398
Std. Dev.	0.938	1.359	1.094	1.369	0.837	0.309	1.063	0.808	0.162	0.081	0.554	0.185
Skewness	0.153	-0.172	-0.175	-0.466	-0.566	0.137	0.842	-0.253	-0.575	-0.591	-0.039	-2.143
Kurtosis	1.712	1.749	1.566	1.783	3.659	7.482	5.659	1.501	2.339	2.301	2.596	15.37
Jarq.-Bera	9.058	8.697	11.26	12.14	8.866	104.16	51.17	12.93	9.079	9.743	0.875	885.7
Probability	0.011	0.013	0.004	0.002	0.012	0.000	0.000	0.002	0.011	0.008	0.645	0.000
Sum	674.88	621.9	681.1	547.4	-220.5	607.09	162.7	118.9	134.2	350.6	465.4	-37.17
Sum Sq. Dev.	108.15	227.5	147.3	230.8	86.15	11.778	139.0	80.38	3.236	0.803	37.69	4.192
Observ.	124	124	124	124	124	124	124	124	124	124	124	124

Appendix C: Summary of unit root result

Stationary crude oil price (LCP)

ADF Test Statistic	-5.336754	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary broad money supply (LM_2)

ADF Test Statistic	-4.279935	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary real output (LRGDP)

ADF Test Statistic	-5.939830	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary crude oil price volatility (LCPV)

ADF Test Statistic	-5.167374	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary exchange rate (LEXR)

ADF Test Statistic	-5.981493	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary crude oil price volatility (LINF)

ADF Test Statistic	-4.122398	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary monetary policy rate (LMPR)

ADF Test Statistic	-5.459410	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary net foreign assets (LNFA)

ADF Test Statistic	-4.143088	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary foreign assets (LFR)

ADF Test Statistic	-4.317772	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary crude oil exports (LOX)

ADF Test Statistic	-4.874889	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary crude oil imports (LOM)

ADF Test Statistic	-5.029898	1% Critical Value*	-3.4900
		5% Critical Value	-2.8874
		10% Critical Value	-2.5804

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary quantity of crude oil production (LQCP)

ADF Test Statistic	-4.480939	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Stationary degree of openness (LDOP)

ADF Test Statistic	-6.980043	1% Critical Value*	-3.4865
		5% Critical Value	-2.8859
		10% Critical Value	-2.5796

*MacKinnon critical values for rejection of hypothesis of a unit root.

Appendix D: Empirical estimates of the models

Model one: monetary policy model

Dependent Variable: LM2
Method: ML - ARCH (Marquardt)
Date: 12/28/11 Time: 11:17
Sample(adjusted): 1981:1 2010:4
Included observations: 120 after adjusting endpoints
Convergence achieved after 39 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
C	1.499410	2.379486	0.630140	0.5286
LCPV(-1)	-0.015548	0.005585	-2.783858	0.0054
LRGDP(-3)	0.085047	0.023680	3.591557	0.0003
LEXR	-0.000148	0.002357	-0.062846	0.9499
LCPI	0.243072	0.063703	3.815686	0.0001
LMPR(-1)	-0.164159	0.061187	-2.682885	0.0073
AR(1)	1.005072	0.003797	264.7272	0.0000
Variance Equation				
C	1.76E-05	8.06E-06	2.189280	0.0286
ARCH(1)	-0.075261	0.032898	-2.287745	0.0222
GARCH(1)	1.060508	0.036707	28.89112	0.0000

R-squared	0.999167	Mean dependent var	5.487332
Adjusted R-squared	0.999099	S.D. dependent var	0.919863
S.E. of regression	0.027617	Akaike info criterion	-4.452124
Sum squared resid	0.083898	Schwarz criterion	-4.219833
Log likelihood	277.1274	F-statistic	14656.53
Durbin-Watson stat	2.124968	Prob(F-statistic)	0.000000

Inverted AR Roots 1.01
Estimated AR process is nonstationary

Model two: net foreign asset model

Dependent Variable: LNFA
Method: ML - ARCH (Marquardt)
Date: 01/04/12 Time: 01:21
Sample(adjusted): 1980:4 2010:4
Included observations: 121 after adjusting endpoints
Failure to improve Likelihood after 40 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
C	4.023588	0.959456	4.193612	0.0000
LCPV	-0.068866	0.030835	-2.233396	0.0255
LM1	0.367389	0.121327	3.028088	0.0025
LRGDP(-1)	-0.070168	0.055346	-1.267806	0.2049
LEXR	0.035138	0.010469	3.356351	0.0008
LFR(-2)	0.140826	0.074095	1.900623	0.0574
AR(1)	0.979801	0.008841	110.8233	0.0000
Variance Equation				
C	-8.76E-05	4.05E-05	-2.162104	0.0306
ARCH(1)	0.187693	0.063618	2.950311	0.0032
GARCH(1)	0.826396	0.041320	20.00015	0.0000

R-squared	0.989188	Mean dependent var	5.048442
Adjusted R-squared	0.988312	S.D. dependent var	1.359768
S.E. of regression	0.147007	Akaike info criterion	-1.594899
Sum squared resid	2.398841	Schwarz criterion	-1.363842
Log likelihood	106.4914	F-statistic	1128.416
Durbin-Watson stat	2.020832	Prob(F-statistic)	0.000000
Inverted AR Roots	.98		

Model three: crude oil export model

Dependent Variable: LOX
Method: ML - ARCH (Marquardt)
Date: 12/28/11 Time: 11:23
Sample(adjusted): 1980:2 2010:4
Included observations: 123 after adjusting endpoints
Convergence achieved after 95 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
C	-38.88361	141.8624	-0.274094	0.7840
LCPV	-0.023805	0.003398	7.006106	0.0000
LQCP	0.781933	0.136989	5.708017	0.0000
LDOP	-0.015863	0.035508	-0.446743	0.6551
LEXR	-0.040312	0.003511	-11.48274	0.0000
LRGDP	-0.007849	0.051767	-0.151628	0.8795
AR(1)	1.000430	0.001432	698.4244	0.0000
Variance Equation				
C	3.44E-05	2.46E-05	1.399536	0.1617
ARCH(1)	0.828951	0.138857	5.969833	0.0000
GARCH(1)	0.510622	0.028535	17.89484	0.0000

R-squared	0.994717	Mean dependent var	5.504866
Adjusted R-squared	0.994296	S.D. dependent var	1.090835
S.E. of regression	0.082387	Akaike info criterion	-3.221894
Sum squared resid	0.767007	Schwarz criterion	-2.993261
Log likelihood	208.1465	F-statistic	2363.817
Durbin-Watson stat	1.976977	Prob(F-statistic)	0.000000
Inverted AR Roots	1.00		
	Estimated AR process is nonstationary		

Model four: crude oil import model

Dependent Variable: LOM
Method: ML - ARCH (Marquardt)
Date: 12/28/11 Time: 11:25
Sample(adjusted): 1980:3 2010:4
Included observations: 122 after adjusting endpoints
Convergence achieved after 14 iterations
Variance backcast: ON

	Coefficient	Std. Error	z-Statistic	Prob.
C	-22.60469	5.806796	-3.892800	0.0001
LCPV	-0.040722	0.094507	-0.430887	0.6666
LQCP(-1)	6.012131	2.001954	3.003131	0.0027
LEXR	0.214731	0.027423	7.830405	0.0000
LRGDP	1.644563	0.191043	8.608338	0.0000
LFR	0.395862	0.130237	3.039549	0.0024
AR(1)	0.891898	0.069348	12.86117	0.0000
	Variance Equation			
C	0.031633	0.009794	3.229929	0.0012
ARCH(1)	-0.038118	0.027124	-1.405335	0.1599
GARCH(1)	0.472344	0.102522	4.607250	0.0000

R-squared	0.973319	Mean dependent var	4.448207
Adjusted R-squared	0.971175	S.D. dependent var	1.355140
S.E. of regression	0.230075	Akaike info criterion	-0.092441
Sum squared resid	5.928681	Schwarz criterion	0.137397
Log likelihood	15.63889	F-statistic	453.9692
Durbin-Watson stat	1.532288	Prob(F-statistic)	0.000000
Inverted AR Roots	.89		