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The Impact of Crude Oil Price Volatility on the Nigerian Economy

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Abstract

This study examines the impact of Crude oil price volatility on the Nigerian economy within the period 2000 to 2016 on monthly basis. It is borne out of the suspicion that crude oil price may be volatile and have impact on the Nigerian Economy. Conditional volatility is estimated with the use of Autoregressive Conditional Heteroskedasticity (ARCH) model and General Autoregressive Conditional Heteroskedasticity (GARCH) model. Structural Vector Autoregressive (SVAR) was used as the analytical technique to carry out the empirical analysis. Using the coefficients of SVAR, the study found that, out of the five variables employed, Crude oil price volatility had significant impact on exchange rates and oil revenue but the impact on interest rates (proxy by maximum lending rate), inflation rates and real income were insignificant. This implies that persistence shock in crude oil price indeed determines the rate at which the naira is exchanged for the dollar, as well as the revenue that accrues to the Nigerian government. Variance decomposition analysis shows variations in the variables as a result of volatility in crude oil prices. The impulse response function analysis shows response of each variable to a unit shock in crude oil price volatility reduces over time. The study recommends diversification of the economy through agriculture and taxation, regulation of exchange rate during persistence fluctuation in oil price and encouraging private sectors to build refineries to boost oil exportation.

Key Words: Impact, Crude Oil Price, Volatility, Economy

INTRODUCTION

The global recession of 2007 to 2009 has brought the importance of understanding the propagation mechanism of oil price volatility to the forefront. The unprecedentedly slow recovery, to which both economists and policy makers identify oil price volatility as one potential risk, has reinforced the significance. Nonetheless, most macroeconomic literature in the past have not focused so primarily on time-varying oil price volatility, presuming that it would have rather little effects on the macro economy.

Since the discovery of oil in commercial quantity in Nigeria in Oloibiri, in the present day Bayelsa State, in 1956, oil has become the major export commodity and revenue earner, displacing agriculture, and contributing nearly 80 percent to total government revenue and 90 percent of foreign exchange earnings. This makes Nigeria susceptible to the happenings in the global oil market, which has been characterized by several episodes of oil price volatility arising from both supply and demand factors.

A number of events in the world economy contributed to observed fluctuation in oil price given the period covered in this study. For instance, the outbreak of Iraq/Iran war in 1980 caused distortion in the trend of global oil price as average global oil price decreased from USD35.52 per barrel (pb) to USD34pb in 1981 when the war ended. In addition, the global financial crisis which started in 2007 reached its peak in 2008 and officially ended in December 2009 also caused irregular movement in global oil price as it increased from USD69.04pb in 2007 to USD94.1 in 2008 and decreased to USD60.86 in 2009 and then increased again to USD77.38. Between the periods of 2010 to 2015, technological advancement brought about improvements in the production of shale oil in the USA as an alternative energy to crude oil. As a result, average global oil price slumped from USD107.46pb in 2011 to USD60.70pb as at December 2014. Despite this development, in 2015 Organization of Petroleum Exporting Countries (OPEC) maintained their production level at thirty million barrel per day (30m b/d) depressing global oil price further. In addition, the low demand by global consumers such as China led to drastic price distortion in the global economy. As a result, the average crude oil price in 31st July, 2014, which stood at USD105.23 pb dwindled to an average of USD54.34pb in 31st July, 2015 and further down to about USD29.78 in January 31st 2016 (World Economic Outlook 2015).

Oil has been a dominant factor in Nigeria's fiscal space since the 1970s. The various episodes of oil price boom since the late 1970s resulted in substantial revenue accretion, which gave the government the much needed leverage to embark on additional expenditure outlays to promote economic growth. Thus, the sizeable oil-windfall over the years has made the country oil dependent and extremely vulnerable to the volatility in international oil prices. A study by the World Bank (2003) found the Nigerian economy among the most volatile in the world between 1961 and 2000. These findings were attributed mainly to oil price volatility.

More recently, there has been profound pressure on the exchange rate with attendant consequences on the external reserves and GDP. The implications of the foregoing might be grave for the macro economy on the long run if the down trend in oil prices as witness in 2015 and 2016 continues. The crisis in the global oil market has left Nigeria in recession since the second quarter of 2016. This study, therefore, contends that the fluctuations in prices in the international oil market have strong implications for the management of Nigeria foreign exchange rate, her oil revenue, real GDP and by extension, other macroeconomic stability in the country. To this end, the study is set to provide answer to these questions: Is there an existence of volatility in Crude-Oil prices? If yes, then, does it impact the naira/dollar Exchange rate, Oil revenue, Maximum lending rate, Inflation rate and Real Gross Domestic Product (RY) in Nigeria?

Following this introductory section is section two, which contains the literature review; the third section contains the research methodology, in which various statistical methods were employed to carryout empirical investigation on the impact of Crude Oil Price Volatility on the Nigerian Economy. Section four and five contains the interpretation of econometric and statistical results, and conclusion and recommendations, respectively.

EMPIRICAL REVIEW

There have been so many studies/researches on the impact of Oil price, impact of oil price volatility on macroeconomic variables like GDP, Exchange rate, Inflation, Unemployment. Umar & Abdulhakeem (2010) study was on o*il price* shocks and the Nigeria economy; Oriakhi and Osaze (2013) studied *oil price volatility* and its consequences on the growth of the Nigerian economy, while Oyeyemi (2013) looked at the growth implications of oil price shock in Nigeria; Apere and Ijeomah (2013) examine the macroeconomic impact of oil price levels and volatility in Nigeria; Ani et al. (2014) analyzes the impact of oil price volatility on economic development utilizing stylized evidence in Nigeria; Alley et al. (2014) looked at the effect of oil price shocks on Nigerian economic growth; Ebele (2015) empirically investigated the impact of oil price volatility on economic growth in Nigeria; while Abdulkareem and Abdulhakeem (2016) analyzes oil price-macroeconomic volatility in Nigeria.

Umar & Abdulhakeem (2010) examined the impact of crude oil price changes on four key macroeconomic variables in Nigeria (GDP, money supply, consumer price index and unemployment). They used data from 1970 to 1980 and employed the VAR methodology. They found that crude oil prices have significant influence on GDP, money supply and unemployment. However, its impact on consumer price index was insignificant. They concluded that oil price volatility affects GDP, money supply and unemployment in Nigeria.

In an attempt to also establish the impact of oil price volatility on the Nigerian macroeconomic variables, Oriakhi & Osaze (2013) examined the effect of oil price volatility on the growth of the Nigerian economy using quarterly data from 1970 to 2010 and employing the VAR methodology. From their findings, we were made to understand that, out of the six variables employed which were: real government expenditure, real exchange rate, real import, real GDP, real money supply and inflation; oil price volatility had a direct impact on three of them, namely: real government expenditure, real exchange rate and real import, while the impact on real GDP, real money supply and inflation was indirect, through other economic variables particularly, real government expenditure. This implies that oil price volatility determines the level of government expenditure which successfully determines growth in Nigeria.

Apere and Ijomah (2013) investigated the relationship between oil price volatility and the Nigerian macroeconomic variables over the space of 1970 to 2009 using exponential generalized autoregressive conditional heteskedasticity (EGARCH) and impulse response function and lag-augmented VAR (LA-VAR) models, it was established that: there was a unidirectional relationship between interest rates, exchange rate and oil prices but no significant relationship between real GDP and oil prices. It was concluded that oil price shock was an important determinant of real exchange rates and in the long run interest rates, and this was what affects output growth in Nigeria rather the oil price shock itself. Hence their conclusion that exchange rate rather than oil price affected the Nigerian GDP within the sample period.

Oyeyemi (2013) using annual data for the period 1979-2010, applying the OLS technique, investigated the impact of oil price volatility on Nigeria's macroeconomic stability. From his research, he found a positive relationship between oil price and the real exchange rate, which implies that an increase in oil price leads to an appreciation of the real exchange rate and also increases in the output level. Specifically, the estimates revealed that a 1 unit change in crude oil price level will cause real GDP to change by 15.0 per cent. He also observed that accumulation of foreign exchange and increase in government capital and recurrent expenditure was as a result of periods of oil boom in Nigeria while its decrease had a destabilizing effect on the balance of payment position and government finances.

Alley et al. (2014) examined the relationship between oil price shocks and Nigerian economic growth, considering the period 1981 to 2012, with the use of Generalized Methods of Moment (GMM) model, the study established that oil price shocks negatively (though not significant) impacted on economic growth but that oil price itself had a positive and significantly impact on it. It was recommended that the Nigerian economy should diversify her export revenue base in order to minimize the reliance on crude oil and petroleum products.
Ani et al. (2014) found that oil price volatility does not have a significant impact on the Gross Domestic Product (GDP) and other important economic variable such as exchange rate in Nigerian, at least not in the short run; but there was a positive, though an insignificant relationship between oil price and Nigerian GDP; and finally, the overall oil price does not have significant impact on Nigeria's GDP and exchange rate. The study concluded that "Countries which are amply endowed with resources tend to grow slower than others as is the case in Nigeria". This study established its findings with the use of Granger Causality and Ordinary least squares models; utilizing annual data from 1980 to 2010. The result suggested that Nigeria has a special case of the Dutch disease, where a country seemingly good fortune proves ultimately detrimental to its economy.

Ebele (2015) studied the relationship between crude oil price volatility and the Nigerian economic growth covering the period 1970 to 2014, adopting Engel-granger co-integration test for testing the long run relationship, and Granger representation theorem in testing the short run relationship. It was found out that there was a negative relationship between oil price volatility and economic growth but a positive relationship existed between economic growth and other macroeconomic variables such as crude oil price, oil revenues and oil reserves. The study recommended a diversification in our export to prevent over reliance on crude oil.

Abdulkareem and Abdulhakeem (2016) studied the impact of oil price shocks on the volatility of some selected macroeconomic variables GARCH model and its variants (GARCH-M, EGARCH and TGARCH) and data based on daily, monthly and quarterly series. It was revealed that: the asymmetric models (TGARCH and EGARCH) out-perform the symmetric models (GARCH (1 1) and GARCH – M); and oil price was a major source of macroeconomic volatility in Nigeria. What that meant was that, the Nigerian economy was not just vulnerable to external shocks (exchange rate volatility and oil price volatility) but also the internal shocks (interest rate volatility, real GDP volatility). Thus, they concluded that more credence should be given to asymmetric models in dealing with macroeconomic volatility in Nigeria and oil price volatility should be considered as relevant variable in the analysis of macroeconomic fluctuations in Nigeria. Their recommendation was that the Nigerian economy should be diversified by revamping other sectors such as the agricultural sector and the industrial sector in order to reduce the impact of oil price uncertainty on macroeconomic volatility.

METHODOLOGY

Model Specification

Crude oil price (COP) returns was specified as adapted from Salisu and Mobolaji (2013) as follows:

$COPR = Log (COPt / COP_{t-1})$……………………………………………………… (1)

Where: COPR= Crude Oil Price Returns

COP = Crude oil Price

This serves as the first stage of variable transformation and an input into the volatility process. For volatility operations, variables are not used in their original form but in their returns form (risk proceed) as rightly transformed above. It is important to state here that crude-oil price is expected to exhibit volatility properties a-priori. This is because volatility is associated with rational expectations of variables that are susceptible to daily spikes dictated by market fundamentals.

To determine the existence (impact of shock) and extent of volatility (persistence of shock) in the variable of interest, the steps followed involved; (1), modeling AR(k) with the generated returns series in equation (1), (2), testing for ARCH/GARCH effect (existence of volatility) and (3), modeling the extent of volatility and generating crude-oil volatility series (GARCH variance series).

Modeling AR(k) (Conditional Mean Model)

In order to specify a model that captures the impact of shock to volatility in crude-oil price, we formulated the simplest version of Autoregressive (AR(k)) (k=1) model. Thus, we have:

$$COPR_t = \alpha_0 + \alpha_1 COPR_{t-1} + \varphi_t \quad \text{……………………………………} (2)$$

The above equation represents the mean equation and provides the basis for which the ARCH/GARCH effect test was conducted. We estimated the model with Ordinary Least Square (OLS) method and followed the necessary process to check for the existence of volatility in crude-oil price (test for ARCH/GARCH effect).

Testing for ARCH Effects (Variance Models)

The ARCH test was used to test for conditional heteroskedasticity (existence of volatility) as suggested by Engle (1982) and applied in Narayan and Narayan (2007). The test was carried out in order to assert whether ARCH/GARCH effect exists in equation (2) and this would give an indication either to retain LS model or proceed to ARCH-type model.

The ARCH type model, for testing the existence of volatility follows the framework of a moving average (MA). More specifically, the square of the contemporaneous residual in equation (2) was regressed on the squares of their lagged residuals.

Algebraically, the ARCH-type model was specified thus:

$\varepsilon t^2 = \lambda + \sum_{i=1}^{p} \delta 1 x^k a^{n-k}$...............................General Form

And in a more explicit form, we have:

$$\varphi^2{}_t = \eta_0 + \eta_1\varphi^2{}_{t-1} + \eta_2\varphi^2{}_{t-2} + \eta_3\varphi^2{}_{t-3} + \ldots + \eta_n\varphi^2{}_{t-n} + \iota_t \ \ldots (3)$$

Hypothesis

The null hypothesis of the ARCH effect is stated as: "no ARCH effect" thus:

$$H_0 : \eta_0 = \eta_1 = \ldots = \eta_n = 0$$

In confirming the significance of the result, the study compares the probability values of F-tests with the conventional level of significance (1 percent, 5 percent and 10 percent). However, for this study, we adopted 5 percent ($p<0.05$) significance level (95 percent confidence level).

Decision making

The null hypothesis is accepted if probability of F-Stat falls outside the conventional levels of significance, that is, if $p>0.05$, it accepts the null hypothesis of no ARCH effect, but where the reverse is the case, the null hypothesis is rejected.

Modeling the Extent of Volatility

The study modeled the extent of volatility by formulating a GARCH (k, p) model. This becomes necessary only if the outcome of the ARCH-effect test on Crude-oil price (COP) shows that it is volatile.

The model for measuring the extent of volatility is a system model that combines both the mean equation and the variance equation. Thus, the extent of volatility for oil price is operationally given thus:

We simultaneously estimated equation (4) and (5) thus:

$$COPR_t = \alpha_0 + \alpha_1 COPR_{t-1} + \varphi_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots, \dots..4$$

$$\varphi^2 t = \eta 0 + \eta 1 \varphi^2{}_{t-1} + \eta 2 \varphi^2{}_{t-2} + \eta 3 \varphi^2{}_{t-3} + \cdots + \eta n \varphi^2{}_{t-n} + lt \dots..5$$

The parameter estimate of the variance equation was considered here. If its mean reversion tends towards 1, it implies slower return to equilibrium or initial level while the reverse is the case when it tends toward zero. However, such inferences are not our focus in this study. The estimated model was only used to make GARCH variance series (Oil price volatility).

To ensure there is indeed an ARCH effect on the GARCH model, the coefficients of ARCH Effect (i.e. Residual Sum of Squares) will be tested to see if it is significant or not, before generating the Oil price volatility

Hypothesis

The null hypothesis of the ARCH effect is stated as: "no ARCH effect" thus:

$$H_0 : \eta_0 = \eta_1 = \dots = \eta_n = 0$$

In confirming the significance of the result, the study compares the probability values of the ARCH parameters with the conventional level of significance (1 percent, 5 percent and 10 percent).However, for this study, we adopted 5 percent ($p<0.05$) significance level (95 percent confidence level).

Decision making

The null hypothesis is accepted if the probability falls outside the conventional levels of significance. That is, if $p>0.05$, it accepts the null hypothesis that there is no ARCH effect, but where the reverse is the case, it will reject the null hypothesis.

Structural Vector Autoregressive (S-VAR)

For the purpose of this study, the Structural Vector Autoregressive (S-VAR) model will be adopted to estimate the impact of Crude-oil price volatility (COPVOL) on naira/dollar Exchange rates (EXRT), Federal collected Oil revenue (FDOR), Interest rate (MLR), Inflation (INF) and economic growth (RY) in Nigeria. Ekperiware and Oladeji (2014) model is adapted to estimate the relationship. The model is modified to capture the relationship between Crude-oil price volatility and Exchange rate, Oil revenue, Maximum lending rate, Interest rate and Real Income.

The endogenous linear equations can be explicitly specified as follows:
$A_oY_t = a + A_1Y_{t-1} + A_2Y_{t-2} + \ldots + ApY_{t-p} + E_t$ …………………………………………… (6)

Yt = {COPVOL, EXRT, FDOR, MLR, INF, RY} is an nx1 dimensional vector of endogeneous variables.

a = vector of constant term

$A_o, A_1 \ldots\ldots A_P$ = the matrix of the coefficients of the variables in the system
E_t = the vector of random disturbance error term, which are assume to be independently and identically distributed error term with zero mean and finite variance.

From the endogenous linear equation, the SVAR model can be expanded indicating the six (6) macroeconomic variables as follows:

$$COPVOL = \sum_{k=0}^{n} h_{11}(k)\varepsilon_{1t-k} + \sum_{k=0}^{n} h_{21}(k)\varepsilon_{2t-k} + \sum_{k=0}^{n} h_{31}(k)\varepsilon_{3t-k} + \sum_{k=0}^{n} h_{41}(k)\varepsilon_{4t-k} + \sum_{k=0}^{n} h_{51}(k)\varepsilon_{5t-k} + \sum_{k=0}^{n} h_{61}(k)\varepsilon_{6t-k} \ldots\ldots (6.1)$$

$$DLEXRT = \sum_{k=0}^{n} h_{12}(k)\varepsilon_{1t-k} + \sum_{k=0}^{n} h_{22}(k)\varepsilon_{2t-k} + \sum_{k=0}^{n} h_{32}(k)\varepsilon_{3t-k} + \sum_{k=0}^{n} h_{42}(k)\varepsilon_{4t-k} + \sum_{k=0}^{n} h_{52}(k)\varepsilon_{5t-k} + \sum_{k=0}^{n} h_{62}(k)\varepsilon_{6t-k} \ldots\ldots (6.2)$$

$$DLFDOR = \sum_{k=0}^{n} h_{13}(k)\varepsilon_{1t-k} + \sum_{k=0}^{n} h_{23}(k)\varepsilon_{2t-k} + \sum_{k=0}^{n} h_{33}(k)\varepsilon_{3t-k} + \sum_{k=0}^{n} h_{43}(k)\varepsilon_{4t-k} + \sum_{k=0}^{n} h_{53}(k)\varepsilon_{5t-k} + \sum_{k=0}^{n} h_{63}(k)\varepsilon_{6t-k} \ldots\ldots. (6.3)$$

$$DMLR = \sum_{k=0}^{n} h_{14}(k)\varepsilon_{1t-k} + \sum_{k=0}^{n} h_{24}(k)\varepsilon_{2t-k} + \sum_{k=0}^{n} h_{34}(k)\varepsilon_{3t-k} + \sum_{k=0}^{n} h_{44}(k)\varepsilon_{4t-k} + \sum_{k=0}^{n} h_{54}(k)\varepsilon_{5t-k} + \sum_{k=0}^{n} h_{64}(k)\varepsilon_{6t-k} \ldots.. (6.4)$$

$$DINF = \sum_{k=0}^{n} h_{15}(k)\varepsilon_{1t-k} + \sum_{k=0}^{n} h_{25}(k)\varepsilon_{2t-k} + \sum_{k=0}^{n} h_{35}(k)\varepsilon_{3t-k} + \sum_{k=0}^{n} h_{45}(k)\varepsilon_{4t-k} + \sum_{k=0}^{n} h_{55}(k)\varepsilon_{5t-k} + \sum_{k=0}^{n} h_{65}(k)\varepsilon_{6t-k} \ldots\ldots.. (6.5)$$

$$DLRY = \sum_{k=0}^{n} h_{16}(k)\varepsilon_{1t-k} + \sum_{k=0}^{n} h_{26}(k)\varepsilon_{2t-k} + \sum_{k=0}^{n} h_{36}(k)\varepsilon_{3t-k} + \sum_{k=0}^{n} h_{46}(k)\varepsilon_{4t-k} + \sum_{k=0}^{n} h_{56}(k)\varepsilon_{5t-k} + \sum_{k=0}^{n} h_{66}(k)\varepsilon_{6t-k} \ldots\ldots. (6.6)$$

Thus, the SVAR equations above in a vector

$$\begin{bmatrix} COPVOL \\ EXRT \\ FDOR \\ MLR \\ INF \\ RY \end{bmatrix} = \begin{bmatrix} h11(k) & h21(k) & h31(k) & h41(k) & h51(k) & h61(k) \\ h12(k) & h22(k) & h32(k) & h42(k) & h52(k) & h62(k) \\ h13(k) & h23(k) & h33(k) & h43(k) & h53(k) & h63(k) \\ h14(k & h24(k) & h34(k) & h44(k) & h54(k) & h64(k) \\ h15(k) & h25(k) & h35(k) & h45(k) & h55(k) & h65(k) \\ h16(k) & h26(k) & h36(k) & h46(k) & h56(k) & h66(k) \end{bmatrix} \begin{bmatrix} e1t \\ e2t \\ e3t \\ e4t \\ e5t \\ e6t \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots(7)$$

The E_{1t} are uncorrelated white noise disturbances and their individual coefficients are expressed as $h_{ij}(k)$. Equation 7 is compactly expressed as:
Yt = h(k) E_t……………………………………………………………………………………(8)

In order to properly estimate the parameters in the SVAR, there is need to place some restrictions on the model.

COPVOL EXRT FDOR MLR INF RY

$$\begin{bmatrix} COPVOL \\ EXRT \\ FDOR \\ MLR \\ INF \\ RY \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ * & 1 & 0 & 0 & * & 0 \\ * & * & 1 & 0 & 0 & 0 \\ * & 0 & 0 & 1 & * & 0 \\ * & * & 0 & 0 & 1 & 0 \\ * & * & * & * & * & 1 \end{bmatrix}$$

The system is identified with n(n-1)/2 zero restrictions on $A_{o.}$ The non-recursive restrictions above are over-identified. The restrictions placed were based on theory of how the economic variables relates with one another. The zero (0) elements are restrictions, while the asterisks (*) elements are the matrix estimated elements.

DATA ANALYSIS AND INTERPRETATION

Crude-oil Price Returns Series (COPR)

Crude Oil Price Returns, denoted by COPR, series was generated from the Crude Oil Price (COP). It was calculated using the formula:

COPR = Log [(COP/COP(-1)]……………………………………….(9)

Where the COP(-1) represents the lag of COP. Results in appendix.

AR(k) is tested COPR generated.

Testing for ARCH Effect using COPR(k)

Table 4.1 presents the ARCH test parameters for Crude-oil price. For robustness, the study extended the mean model in equation two to AR(2), hence K=1,2

Table 4.1: ARCH Test

Dependent variable: COPR						
Model	p=1		p=2		p=3	
	F-test	nR^2	F-test	nR^2	F-test	nR^2
	COPR	COPR	COPR	COPR	COPR	COPR
k = 1	7.077*	6.903*	4.082**	7.958**	2.738**	8.044**
k = 2	7.127*	6.949*	3.665**	7.174**	2.877**	8.435**

Note: Model follows the autoregressive process of k = 1 and k=2 respectively and p is the lag length for the test statistics. * = 1per cent level of significance; ** = 5per cent level of significance; ***=10per cent level of significance

Source: *Computed using E-Views 9 Software Package*

The results confirmed the presence of ARCH effect at the lag length – (p=1, p=2 and p=3) at the 5 per cent level of significance. Thus, the null hypothesis (H_0) of no ARCH effect was rejected. Consequently, the study proceeded to estimate the extent of Crude oil price volatility using the ARCH-type model.

Estimating GARCH (1, 1)1

Following the results above, the study modeled the extent of volatility using GARCH (1, 1) model. Table 4.2 summarizes the coefficient of variance equation, which was used in generating GARCH variance series, named Oil price volatility series.

Table 4.2: GARCH (1, 1)

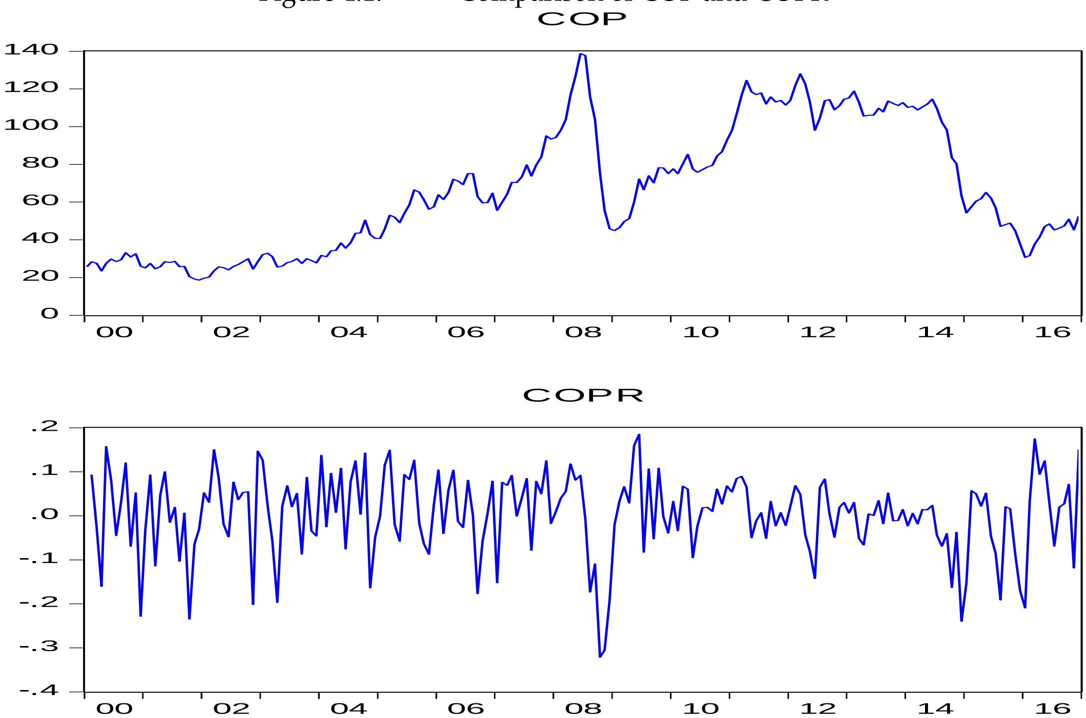
	Mean equation		Variance equation			Diagnostics:			ARCH LM test on Models	
Variable	α_0	α_1	η_0	η_1	η_2	AIC	SIC	HQC	F-Statistics	nR^2
GARCH (1,1)	0.002***	0.176**	0.0004***	0.165*	0.793*	-2.003	-1.922	-1.971	0.022***	0.022***

Note: * = 1per cent level of significance; ** = 5per cent level of significance; ***= 10per cent level of significance

Source: *Computed using E-Views 9 Software Package*

As revealed from Table 4.2, the coefficients of variance – ARCH Effect (η_1) from the GARCH (1,1) model is seen to be significance at 5 per cent level of significance. Thus, the null hypothesis (H_0) of no ARCH effect was rejected. Based on the above results, GARCH variance series was generated and used as the oil price volatility series in the study.

Figure 4.1: Comparison of COP and COPR



Source: *Computed using E-Views 9 Software Package*

From figure 4.1, it is absolutely clear that COPR is more volatile than COP and this makes it suitable for an ARCH operation.

Unit Root Tests

The results of the unit root tests are shown in Table 4.3

Table 4.3: Unit root test using the SIC and Newey-West Bandwidth Criterion

Variables	ADF Test Statistic	Longest Lag	Order of Integration	PP Test Statistic	Longest Bandwidth	Order of Integration
COPVOL	-3.974267*	14	I(0)	-3.714131*	4	I(0)
LEXRT	-11.11705*	14	I(1)	-10.95364*	5	I(1)
LFDOR	-20.03443*	14	I(1)	-19.98948*	1	I(1)
MLR	-13.83175*	14	I(1)	-13.88077*	4	I(1)
INF	-3.546240*	14	I(0)	-3.823885*	4	I(0)
LRY	-6.500137*	14	I(1)	-6.123589	9	I(1)

Note: *= 1per cent level of significance; ** = 5per cent level of significance; *** = 10per cent level of Significance
Source: *Computed using E-Views 9 Software Package*

As seen in Table 4.3, Augmented Dickey Fuller (ADF) test for stationarity at various lag lengths using the SIC criterion shows that LEXRT, LFDOR, MLR, and LRY, are not stationary at their levels but stationary at their first difference, while COPVOL and INF are stationary at their level.

The Philip Perron (PP) test confirms the same results. Thus, we can conclude that the series are integrated of order one, I(1). In addition, the results suggest that the variables need to be transformed in order to be devoid of spuriousness

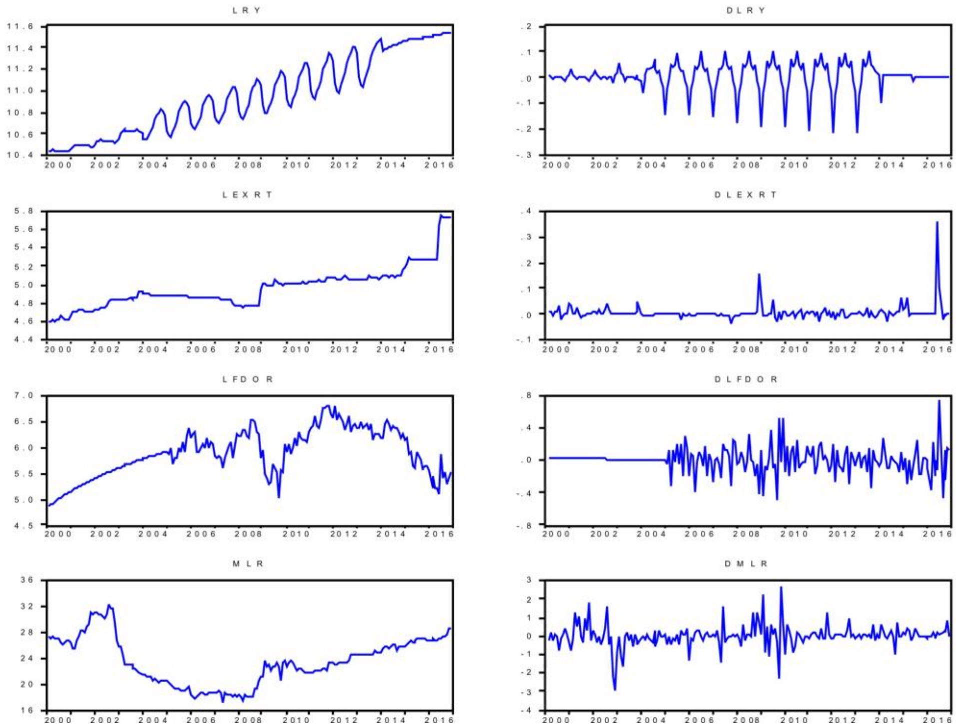


Fig 4.2 Trend of Stationarity and Non-Stationarity of Variables in the model

Source: Computed using E-Views 9 Software Package

Figure 4.2 depicts the trend of Stationary and Non-stationary variables employed. Four (4) Variables, namely: LEXRT, LFDOR, MLR and LRY were shown because they are not stationary at their levels but at their first difference. Figure 4.2 is evidence that the series are only stable at their first difference, hence, the generation of DLRY, DLEXRT, LFDOR and DMLR. INF and COPVOL were not included because they were stationary at levels.

Co-integration

With the observation of some of the variables have unit root problem, that is, not stationary at their levels, a co-integration test becomes a necessity. This test is carried out using the Johansen approach. Table 4.5 is an extract from the co-integration result.

Table 4.4: Cointegration Test

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.46253	361.1595	95.75366	0
At most 1 *	0.356925	236.983	69.81889	0
At most 2 *	0.272348	148.6844	47.85613	0
At most 3 *	0.217986	85.0978	29.79707	0
At most 4 *	0.110609	35.92124	15.49471	0
At most 5 *	0.060481	12.4775	3.841466	0.0004

Source: *Computed using E-Views 9 Software Package*

Table 4.4 shows co-integration result using Johansen Co-integration test. The result indicates 5 co-integrating equation indicating that all the variables are co-integrated at 1% level of significance. This result indicates that there exists a long-run equilibrium relationship among the variables under study.

VAR Lag Order Selection Criteria

Table 4.5: Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	798.0680	NA	1.15e-11	-8.165650	-8.064582	-8.124725
1	1168.896	714.8955	3.63e-13*	-11.61749	-10.91001*	-11.33101*
2	1203.017	63.66804	3.70e-13	-11.59811	-10.28423	-11.06608
3	1237.089	61.47067	3.79e-13	-11.57824	-9.657948	-10.80066
4	1260.977	41.61907	4.31e-13	-11.45337	-8.926674	-10.43024
5	1285.332	40.92626	4.90e-13	-11.33332	-8.200215	-10.06464
6	1351.116	106.4755*	3.65e-13	-11.64037*	-7.900862	-10.12614
7	1377.414	40.93755	4.10e-13	-11.54035	-7.194431	-9.780563
8	1402.552	37.57803	4.69e-13	-11.42837	-6.476049	-9.423036

Source: *Computed using E-Views 9 Software Package*

In order to properly estimate a VAR model which is an input in estimating SVAR model, it is necessary to get the optimal lag length using Lag length selection criteria. Lag length selection criteria of VAR starts with the specification of maximum lag of 8. An asterik (*) indicates the selected lag from each column of the criterion statistic. From the result in table 4.5, we considered the first (1) lag length as the optimal lag length for each endogenous variable based on the Schwarz information criterion (SIC). Schwarz information criterion is chosen because it has been shown to have a higher degree of precision when compared to other criterions such as the Akaike information criterion (AIC).

Estimated Structural Vector Autoregressive (SVAR) Model.

Table 4.6: SVAR Estimates

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	477.8454	23.83276	20.04994	0.0000
C(2)	32.93936	1.642866	20.04994	0.0000
C(3)	6.860206	0.342156	20.04994	0.0000
C(4)	-1.6278	0.081187	-20.0499	0.0000
C(5)	-0.49695	0.024786	-20.0499	0.0000
C(6)	22.08835	1.101667	20.04994	0.0000
C(7)	0.169253	0.071651	2.362201	0.0182
C(8)	-0.14377	0.071294	-2.01652	0.0437
C(9)	-0.07026	0.070767	-0.99282	0.3208
C(10)	-0.00907	0.070537	-0.12854	0.8977
C(11)	0.009300	0.070770	0.131414	0.8954
C(12)	-0.03153	0.070570	-0.44673	0.6551
C(13)	-0.05189	0.070634	-0.73465	0.4626
C(14)	-0.01151	0.070539	-0.1631	0.8704
C(15)	-0.05962	0.070660	-0.84371	0.3988
C(16)	-0.057	0.070614	-0.80723	0.4195
C(17)	0.040922	0.070594	0.579678	0.5621
C(18)	-0.01509	0.070764	-0.21324	0.8311

Estimated A matrix:						
	COPVOL	DLEXRT	DLFDOR	MDLR	INF	DLRY
COPVOL	477.8454	0.000000	0.000000	0.000000	0.000000	0.000000
DLEXRT	0.000000	32.93936	0.000000	0.000000	0.000000	0.000000
DLFDOR	0.000000	0.000000	6.860206	0.000000	0.000000	0.000000
DMLR	0.000000	0.000000	0.000000	-1.6278	0.000000	0.000000
INF	0.000000	0.000000	0.000000	0.000000	-0.49695	0.000000
DLRY	0.000000	0.000000	0.000000	0.000000	0.000000	22.08835
Estimated B matrix:						
	COPVOL	DLEXRT	DLFDOR	MDLR	INF	DLRY
COPVOL	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000
DLEXRT	0.169253	1.000000	0.000000	0.000000	-0.057	0.000000
DLFDOR	-0.14377	-0.03153	1.000000	0.000000	0.000000	0.000000
DMLR	-0.07026	0.000000	0.000000	1.000000	0.040922	0.000000
INF	-0.00907	0.000000	0.000000	0.000000	1.000000	0.000000
DLRY	0.009300	-0.05189	-0.01151	-0.05962	-0.01509	1.000000

The equations below are extracted from table 4.6:

DLEXRT = 32.8879+0.1699253COPVOL+(-0.057)INF
= 32.8879+0.1699253COPVOL-0.057INF……….......................... (10)

DLFDOR = 6.86206 + (-0.14376)COPVOL + (-0.03153)DLEXRT
= 6.859805 - 0.14376COPVOL – 0.03153DLEXRT ………... (11)

DMLR = -1.6278 + (-0.07026)COPVOL + 0.0409221INF
= -1.62778 - 0.07026COPVOL + 0. 0409221INF ……….. (12)

INF = -0.49695 + (-0.00907)COPVOL
= -0.49773 - 0.00907COPVOL ………. (13)

DLRY = 22.08835 + 0.0093COPVOL - 0.05189DLEXRT - 0.01151DLFDOR - 0.05962DMLR - 0.01803INF …………(14)

Where:
DLEXRT – Exchange; DLFDOR – Oil revenue; RY – Real income (all logged and integrated); DMLR – Maximum lending rate (integrated); INF – Inflation and COPVOL – Crude oil price volatility;
With our focus on coefficients of Crude-oil price volatility (COPVOL) as it relates to the macroeconomics variables: Exchange rate, Oil revenue, Maximum lending rate, Inflation and Gross domestic product, C(7)…C(11) is interpreted.

A unit change in COPVOL, will results in increase in EXRT by approximately 0.17 percents, while holding other variables constant. The positive sign on DLEXRT does not signify good news to the Nigerian economy as it translated to an increase in Exchange rate. With an increase in exchange rate, more units of naira will be given up for a unit of dollar, that is, there is depreciation of the naira. The lower probability value when compared to the conventional level of significance denotes that the impact is significant.

A unit change in COPVOL, while holding other variables constant will lead to decrease in FDOR by 0.14 percents. The results signify that the change is significant judging by the probability value which is lower than the conventional level of significance. Maximum lending rate will decrease by approximately 0.07units, if there is a unit change in COPVOL with other variables being held constant. The COPVOL coefficient is not significant considering the probability value which is higher than the conventional level of significance. A unit change in COPVOL with other variables held constant will decrease inflation by approximately 0.01 units. The probability value is higher than the conventional level of significance, which means the COPVOL coefficient is insignificant. Real income (RY) will increase by approximately 0.01 per cent if there is a unit change in COPVOL with other variables held constant. The impact of a unit change in COPVOL is insignificant as shown by the probability value; it is higher than the conventional level of significance.

SVAR Forecast Error variance decomposition

Table 4.8: Forecast Error variance decomposition

Period	DLEXRT	DLFDOR	DMLR	INF	DLRY
1	2.776432	2.023068	0.490392	0.490392	0.00822
2	3.853506	1.710517	0.523614	0.523614	0.311531
3	4.523138	1.959137	0.58691	0.58691	0.912801
4	5.023794	2.069244	0.638335	0.638335	1.724281
5	5.399045	2.177443	0.692366	0.692366	2.675904
6	5.688595	2.248504	0.742376	0.742376	3.702873
7	5.912043	2.301107	0.788883	0.788883	4.754156
8	6.085417	2.337721	0.830836	0.830836	5.79057
9	6.220159	2.363576	0.868265	0.868265	6.784176
10	6.325127	2.38159	0.901238	0.901238	7.716341

Source: *Computed using E-Views 9 Software Package*

Variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregressive. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. The relative contributions of Crude-oil volatility to the variations in Exchange rate (DLEXRT), Oil revenue (DLFDOR), Maximum lending rates (DMLR), Inflation rates (INF), and Real income (DLRY) is captured using the variance decomposition. It is generated from the estimated SVAR. From table 4.8, COPVOL contributes most to the variance in Real Income in the 9th and 10th period with approximately 6.78 percent; 7.71 percent. For Exchange rate COPVOL contributes 6.21 percent and 6.32 percent in period 9 and 10. Inflation (INF) shows a record of 0.91 percent variation in period 10. The variation in Oil revenue (DLFDOR) seems to be stable as it records approximately 2.07 percent to 2.38 percent from the 4th period up to the last (10th) period. Maximum lending rates (MLR) variation increases overtime but not in a skyrocketed manner, Crude-oil volatility (COPVOL) accounts for 0.49 percent variation in Maximum lending rate (MLR) in 1st and 0.9 percent in the 10th period.

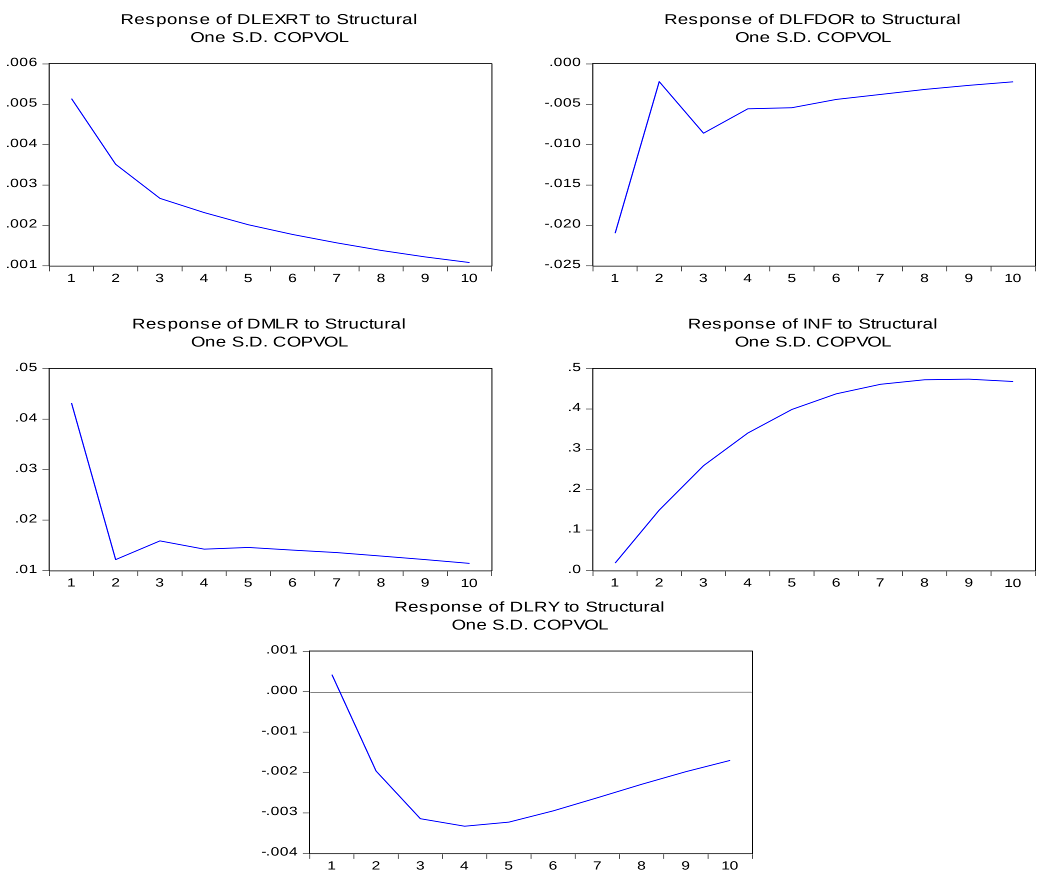
Impulse Response Function

Impulse is an unexpected shock on an economy variable, the reaction of another economy variable to the impulse is referred to as response. It is derived from the estimated SVAR.

Table 4.9: Impulse Response Function

Period	EXRT	FDOR	MLR	INF	RY
1	0.005138	-0.02096	0.043162	0.018245	0.000421
2	0.003515	-0.00219	0.012141	0.149614	-0.00196
3	0.00267	-0.00858	0.015852	0.2596	-0.00315
4	0.002316	-0.00556	0.014231	0.34045	-0.00333
5	0.002015	-0.00543	0.014577	0.398673	-0.00323
6	0.001777	-0.0044	0.014026	0.437611	-0.00295
7	0.001565	-0.00379	0.013531	0.461163	-0.00263
8	0.001382	-0.00317	0.012855	0.472389	-0.00229
9	0.001221	-0.00266	0.012146	0.473963	-0.00198
10	0.001079	-0.00222	0.011403	0.46808	-0.0017

Figure 4.4: Impulse Response Function



***Source:** Computed using E-Views 9 Software Package*

Figure 4.4 graphically depicts responses of DLEXRT, DLFDOR, DMLR, INF and DLRY to a shock in Crude-oil price volatility over a period of ten (10) months. As seen in the graph, there is a positive but declining response from DLEXRT to a shock in COPVOL. There is an indication from the declining rate that if shock continues into the future, response from DLEXRT may eventually be zero and even negative. The positive response of DLEXRT to COPVOL is not a good signal for Nigerian economy as it means value of naira to dollar depreciates; that is, more units of naira will be given up to get a unit of dollar.

DLFDOR is seen to have a decreasing negative response to shock in COPVOL. The response from first period up to third period were unstable but stable afterward and it is leaning towards the positive region as indicated from its position in the last (10^{th}) period.
Shock in COPVOL causes a decreasing positive response from DMLR. It is observed, there is a sharp decrease between the response in first period and second period, a fluctuating one from the second to the fifth after which the response became stable by declining at a seeming constant rate. If this continues into the future, response of DMLR may eventually be zero and probably negative.

There is an indication that INF has direct relationship with shocks in COPVOL. Its response over the time is positive and an increasing one until ninth period where the response reaches its peak and starts declining. This suggests that INF response to shock in COPVOL at later period will be minimal compare to earlier period.
DLRY response to volatility in Crude-oil price is at its highest in the first period after which it assumes a continuous decrease to the 7^{th} period where the downturn occurs. There is an indication that if the trend continues, DLRY may eventually be zero and assumes positive response to persistence shock in Crude-oil price.

Interpretation of Results
The empirical analysis carried out in the course of this study starting from January 2000 – December 2016 has helped to answer the set out research questions; it empirically shows the existence of volatility in Crude-oil price and ascertain the impact of the persistence shock in Crude-oil price on Nigerian economy.

i. Following the result of the ARCH Test as shown in Table 4.1, with the probability of the ARCH test value lower than the conventional level of significance five percent, there is no enough information to accept the null hypothesis (H_0) of no volatility in Crude-oil price.
ii. The SVAR estimates results, *Table 4.8* shows that Crude-oil price volatility has significant impact on Exchange rate, therefore, the null hypothesis (H_0): Crude-oil price does not have a significant impact on Exchange rate is rejected.
iii. The falls of the probability value of Oil revenue is a proof that existence of volatility in Crude-oil price have significant impact on it during the period considered. Therefore, we reject the null hypothesis (H_0): Crude-oil price does not have a significant impact on Oil revenue.
iv. Unlike the case of Exchange rate and Oil revenue where there is a significant impact, the situation is different for Maximum lending rate as the empirical analysis shows that persistent shock (volatility) in Crude-oil price does have impact on Maximum lending rate, but the impact is not significant. This necessitates the decision to accept the null hypothesis (H_0): Crude-oil price volatility does not have a significant impact on Maximum lending rate in Nigeria.
v. Also, results indicate that Crude-oil price volatility have impact on Inflation rate but when subjected to test of significance, it was observed that the impact is insignificant. Therefore, the decision to accept the null hypothesis: H_0: Crude-oil price volatility does not have a significant impact on Inflation rate in Nigeria.

vi. The null hypothesis (H_0): Crude-oil price volatility does not have a significant impact on Real income is accepted as the result shows that the impact of Crude-oil volatility does have impact on real income but not a significant one.

Post Estimation

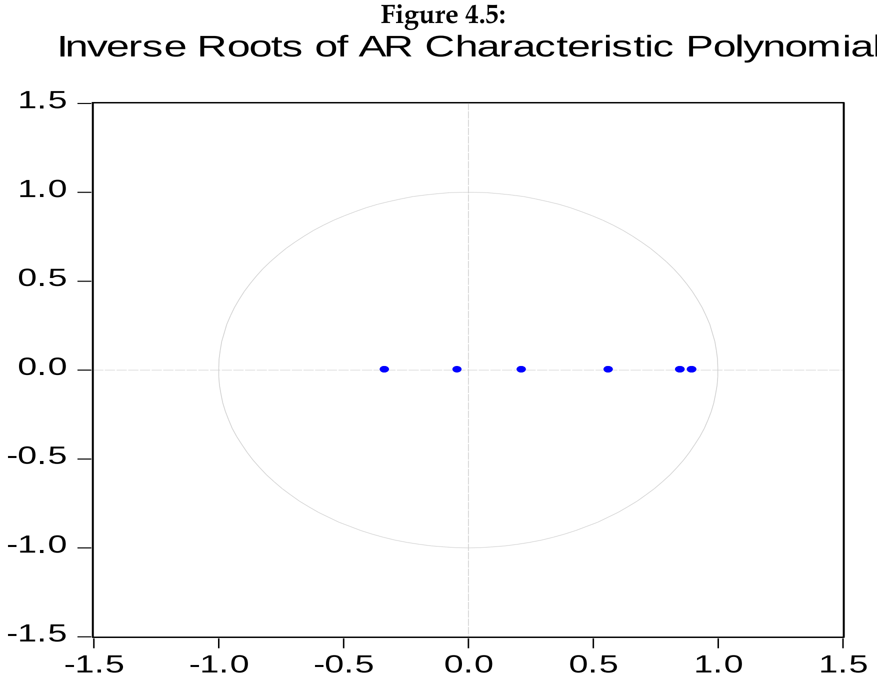
It is a necessity to test the SVAR model for stability to validate the Impulse response function and variance decomposition results. This can be done using the AR Root method. The conditions to declare a model stable using AR roots are: all roots must lie within the polynomial bound and the roots must be less than one. Below is the tabular and graphical representation of the AR Roots test.

Table 4.10: Polynomial Test

Roots of Characteristic Polynomial	
Endogenous variables: COPVOL DLEXRT DLFDOR DMLR INF DLRY	
Exogenous variables: C	
Root	Modulus
0.898715	0.898715
0.851265	0.851265
0.565784	0.565784
-0.331091	0.331091
0.216677	0.216677
-0.039658	0.039658
No root lies outside the unit circle.	
VAR satisfies the stability condition.	

This shows that values of the roots are less than unity. Also, the modulus values are also less than unity and the inverse roots of the AR characteristic polynomials lie within the unit circle. This is as shown in table 4.9. Based on these observations we conclude that the estimated SVAR model is stable.

Figure 4.5:



The laying of all the roots within the polynomial is an indication that the model is good and stable and can be used for forecasting and policy decision.

CONCLUSION AND RECOMMENDATIONS

From the findings, it is evident that volatility exists in Crude-oil price, and it has a linkage with Nigerian economic growth vis-à-vis market global Crude-oil price, Exchange Rate, Oil revenue, Interest rate which is proxy by Maximum lending rate, Inflation and Real income.

It is no surprise that Oil price volatility impacts on Exchange rate and oil revenue are significant, after all, it is the major resource in Nigeria; it accounts for eighty per cent of the revenue and ninety per cent of the foreign earnings. This study therefore is an agreement with some studies conclusion that persistent shock in Crude-oil price is a major determinant of changes in some key macroeconomic variables such as exchange rate and oil revenue.

Based on the conclusion drawn and findings in the course of this paper, particularly the results of the regression models, it is clear that the development of the Nigerian economy is highly dependent on Oil which no doubt is the major source of revenue.

The following recommendations are hereby made:

i. Government should deepen the reform of diversification to at least reduce the over-reliance on oil revenue. For instance, agriculture can be boosted by empowering and encouraging people to go into farming through the provision of lands and machineries, easy access and non-interest loan to existing farmers and those willing to go into it. Diversifying the economy from its present mono-product structure will ease the vulnerability towards adverse and persistent Oil price shocks.

ii. A proper exchange rate management should be set up by the government through the adoption of regulated exchange rate regime to stabilize the economy and bring about external balance.

iii. Also, it has been established that volatility affect oil revenue, therefore, the Federal Inland Revenue Service (FIRS) should broaden the tax base to generate more revenue to supplement the dwindling returns from oil revenue which is attributed to volatility.

iv. In times of persistence shock in Crude-oil price, government should regulate the lending rate to sustain investment and reduce the effect of oil volatility on bank lending.

v. Central Bank of Nigeria (CBN) should control monetary instruments such as money supply to control inflation and regulate price level in the economy. Central Bank should make more stringent punishment for non-compliance to the monetary policies by financial institutions. This will help to cushion the effect of persistence shock in Crude oil price.

REFERENCES

Abdulkareem, A. and Abdulhakeem, K. A. (2016). Analyzing Oil Price - Macroeconomic Volatility in Nigeria, *CBN Journal of Applied Statistics, Vol. 7 No. 1(a) (June, 2016)*.

Alley, I., Asekomeh, A., Mobolaji, H., Adeniran, Y. A., (2014). Oil Price Shocks and Nigerian Economic Growth, *European Scientific Journal 2014 Edition Vol. 10. No. 19.*

Ani et al. (2014). Oil price volatility and economic development: Stylized evidence in Nigeria, *Journal of Economics and International Finance, Vol. 6(6), pp.125-133, June 2014.*

Apere, O. & Ijomah, A.M. (2013). Macroeconomic Impact of Oil Price levels and Volatility in Nigeria, *International Journal of Academic Research in Economics and Management Sciences July, 15-25.*

Ebele (2015). Oil price volatility and economic growth in Nigeria: An empirical investigation, *European Journal of Humanities and Social Science, Vol. 34, No.1.*

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica, 50(4), 987– 1007.*

Ekperiware and Oladeji, (2014), "External Debt, Servicing and Debt Relief Transmissions in Nigeria", *Journal of Economics and Sustainable Development, Vol. 5, No. 20, 2014.*

Narayan, P. and Narayan, S. (2007). Modelling Oil Price Volatility, *Energy Policy 35, 6549-6553.*

Oriakhi, R. and Osaze, A. (2013). An examination of oil prices and its changes on the Nigerian economic growth. *Journal on Welfare economics, 4(2): 25-28.*

Oyeyemi, A. M. (2013). The Growth Implications of Oil Price Shock in Nigeria, *Journal of Emerging Trends in Economics and Management Sciences (JETEMS) 4(3):343-349.*

Salisu, A. and Mobolaji, H. (2013). Modeling returns and volatility transmission between oil price and US–Nigeria exchange rate, *Energy Economics*, *39: 169-176*

Umar, G. and Abdulhakeem, K. (2010). *Oil Price* Shocks and the Nigeria Economy: A Variance Autoregressive (VAR) Model", *International Journal of Business and Management Vol. 5, No.8.*

World Bank, (2003), Nigeria Policy Options for Growth and Stability, *Report No. 26215-NGA, Washington, DC: The World Bank.*

World Bank (2013). Nigeria Economic Report (No.1). Washington, DC: World Bank.

World Economic Outlook Database (2015).