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Review

Symmetric and asymmetric effect of oil price volatility on macroeconomic variables in Nigeria

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Abstract

This study mainly aimed at investigating the symmetric and asymmetric effects of crude oil shocks on key macroeconomic variables for the Nigerian economy. The exponential EGARCH (p,q) model was used to estimate the volatility while VAR model was used to estimate the dynamic structural relationships between oil price volatility and macroeconomic variables. Empirical results suggest that volatility in all the selected macroeconomic variables except interest rate, takes long time to die out following a crisis in the oil price market. Symmetry shocks to oil price significantly influence exchange rate, output, unemployment rate and government spending while for the asymmetric specification, both positive and negative oil price granger causes exchange rate of the naira also, positive rather than negative shocks to oil price explain more variations in unemployment rate in the long run.

Key words: *Oil price, Volatility, Macroeconomic Variables, EGARCH model, VAR model.*

INTRODUCTION

The Nigerian economy, which for so long has been criticized for its one dimensional economy relies heavily on export of crude oil. The Nigeria's oil statistics shows that the country has an estimated 36.2 billion barrels of oil reserve which places the country as the second largest in terms of oil reserve in the entire African continent. The Nigerian oil sector accounts for over 95 per cent of export earnings and about 85 per cent of government revenues. Its contribution to GDP, however, stood at 21.9 and 19.4 per cent in 2006 and 2007 respectively. EIA (2009) estimates Nigeria's effective oil production capacity to be around 2.7 million barrels per day (bbl/d).

The current plunge in the price of crude oil in the international market is sending economic and political shockwaves around the world. The reality of possible crippling budget shortfalls also stares many oil exporting countries in the face as the priced commodity hit its lowest prices in four years. Crude oil prices have been on the decline globally since June 2014, nearing $83 per barrel, down about $32, or 28 per cent, from its high point earlier in the year. The Bonny Light, Nigeria's reference crude is trading at about $83 per barrel. It is noteworthy that crude oil is not just the principal export commodity of Nigeria; every aspect of the country's life revolves around the commodity. For instance, the annual Appropriation Bill, which outlines the direction the country, intends to go at any given year is prepared, based on the price of crude oil. The 2015 budget was prepared based on $78 per barrel oil benchmark.

Given that the past episodes of such sharp declines coincided with substantial fluctuations in activity and inflation, the causes and consequences of and possible policy responses to the recent plunge in oil prices have generated intensive debates with analysts wondering what would happen if crude oil price drops below the budget benchmark. This paper presents an assessment of the recent oil price drop by considering both the symmetric and asymmetric effect of oil price on key macroeconomic variables.

LITERATURE REVIEW

There are several studies addressing the question of whether there is a relationship between oil price shocks and macroeconomic key variables. One of the pioneer works on oil price shocks was carried out by Hamilton (1983), who focused on the US economy. He finds that oil price shocks (in a linear definition) were an important factor in almost all US recessions over 1949-1973. Hamilton concludes that changes in oil prices Granger-caused changes in unemployment and GNP in the US economy. By using VAR models for Canada, Germany, Japan, the United Kingdom and the United States, (Burbidge and Harrison, 1984) show that oil price shocks have a significant negative impact on industrial production. However, they conclude that oil price changes have different impacts on the macroeconomy before 1973 than after. Similar results are produced by (Gisser and Goodwin, 1986) for the US.

Hamilton (1983); Mork (1989), proposed an asymmetric definition of oil prices and distinguished between positive and negative oil price changes. He defined oil price changes as follows:

$$\Delta roilp_t^{+} = \max(0, (roilp_t - roip_{t-1})) \quad (1)$$

$$\Delta roilp_t^{-} = \min(0, (roilp_t - roip_{t-1})) \quad (2)$$

where $roilp_t$ is the log of real oil price in time *t*. Mork showed that there is an asymmetry in the responses of macroeconomic variables to oil price increases and decreases. He concluded that positive oil price changes have a strongly negative and significant relationship with changes in real GNP while negative oil price changes exhibit no significant effects. Mork (1994), argued that this happened because of the important role of oil as a means of production. Changes in its prices lead to the reallocation of resources in the economy. This reallocation of resources may lead to slower GDP growth.

Hooker (1996), criticized Hamilton (1983), in finding evidence that oil prices do not seem to be more endogenous to the US macroeconomy. He pointed out that oil prices (in linear as well as non-linear specifications) do not Granger-cause most macroeconomic indicators in quarterly data from 1973 up to 1994.

In response to Hooker (1996); Hamilton (1996), suggested another form of non-linear transformation of real oil prices. Hamilton states that most of the oil price increases are simply corrections of earlier declines. He argues that if researchers want to measure how unsettling an increase in the prices of oil is likely to be for the spending decision of consumers and firms, it seems more appropriate to compare the current price of oil with that during the previous year rather than during the previous quarter alone (Hamilton, 1996). Hamilton thus proposes using the percentage change over the previous year's maximum if the oil price of the current quarter exceeds the value of the preceding four quarters' maximum. If the price of oil in *t* is lower than in the previous year, the $noilp^{+}$ is defined to be zero in quarter *t*. In this case no positive oil price shocks have occurred.

$$noilp_t^{+} = \max[0, (roilp_t) - \max((roip_{t-1}), \ldots\ldots\ldots, (roilp_{t-4}))] \quad (3)$$

$$noilp_t^{-} = \min[0, (roilp_t) - \min((roip_{t-1}), \ldots\ldots\ldots, (roilp_{t-4}))] \quad (4)$$

In his study, net nominal oil price increases are significant in explaining growth in the Nigeria real GDP. Hamilton (2003), returned to the issue of the linear versus non-linear relationship between oil price changes and GNP growth. He asserts that "Oil price increases are much more important than oil price decreases, and increases have significantly less predictive content if they simply correct earlier decreases" (Hamilton, 2003).

The macroeconomic literature has also identified three primary routes to the asymmetry between oil price changes and economic growth: the sectoral shifts hypothesis (costly rearrangement of factors across sectors that are affected differently by the oil price change); the demand composition route; and the investment pause effect (along the lines of the irreversible investment model, in which households and firms defer major purchases in the face of uncertainty). Thus, studies linking oil prices to the macroeconomy through these channels: sectoral shifts or labor market dispersion (Loungani, 1986; Davis and Mahidhara, 1997; Carruth et al. 1998; Finn, 2000;Davis and Haltiwanger, 2001), consumption or demand decomposition route (Hamilton, 1988, 2003; Bresnahan and Ramey, 1992, 1993; Lee and Ni, 2002) and investment uncertainty (Bernanke, 1983; Dixit and Pindyck, 1994; International Monetary Fund, 2005). Others include the consequences for inflation (Pierce and Enzler, 1974; Mork, 1981; Bruno and Sachs, 1982), suggest that indirect transmission mechanisms may be the crucial means by which oil price shocks have macroeconomic consequences.

Oil price shocks, therefore, receive considerable attention for their presumed macroeconomic consequences. Mork (1989), Lee, Ni and Ratti (1995), and Hamilton (1996), introduces non-linear transformations of oil prices to re-establish the negative relationship between increases in oil prices and economic downturns, as well as to analyze Granger causality between both variables.

METHODOLOGY

We adopted two models for this paper in order to meet the objectives above. These models are the Exponential GARCH (EGARCH) model and the vector Autoregressive **(**VAR**)** which may be transformed to vector Error correction.

Data

Quarterly data is basically secondary. The secondary data of oil price was collected from the International Monetary Fund and International Energy Agency websites. Data of key macroeconomic variables (i.e. real effective exchange rate (exch), inflation rate (inf), unemployment rate (une), real gross domestic product (gdp),real government spending (gex), Interest rate (intr), and balance of payment (bop) proxied by current account balance, was obtained from the central Bank of Nigeria (CBN) publications, National Bureau of statistics (NRS) and the World Bank publications.

Exponential GARCH (EGARCH) Model

The Exponential GARCH (EGARCH) model was introduced byNelson (1991), to overcome some weakness of the GARCH model. In particular, it allows for asymmetric effects between positive and negative asset returns. Conditional variance in this case is specified as:

$$In(h_t) = w + \alpha_1 z_{t-1} + \gamma_1\left(\left|z_{t-i}\right| - E\left(\left|z_{t-i}\right|\right)\right) + \beta \ln(h_{t-i}) \quad (5)$$

where $\ln(h_t)$ = the logarithm of conditional variance z_{t-i} = past shocks

α_1, β_1 and γ_1 are parameters which have no restriction in order to ensure that h_t is non-negative. EGARCH model shows the relationship between past shocks and the logarithm of the conditional variance. When we adopt the properties of shocks, z_t then:

$g(z_t) = \alpha_1 z_{t-1} + \gamma_1\left(\left|z_t\right| - E\left(\left|z_t\right|\right)\right)$ with zero mean and uncorrelated. The above function is pairwise linear in z_t because it can be specified as :

$$g(z_t) = (\alpha_1 + \gamma_1) z_t I(z_t > 0) + (\alpha_1 - \gamma_1) z_t I(z_t < 0) - \gamma_1 E(\left(\left|z_{t-i}\right|\right) \quad (6)$$

where $\alpha_1 + \gamma_1$ = the impact of positive shocks on log of conditional variance .

$\alpha_1 - \gamma_1$ = the impact of negative shocks on log of conditional variance.

We used News lmpact Curve (NIC) to show how new information is incorporated into volatility. NIC shows the relationship between the current shock, e_t , and the conditional volatility of other periods ahead, h_{t-i} holding constant all other past and current informations. In this model, NIC is specified

as $A\exp(\alpha_1 + \gamma_1)/\delta * e_t$ for $e_t > 0$

$$NIC(e/h_t = \delta^2) = A\exp(\alpha_1 - \gamma_1)/\delta * e_t \quad e_t < 0$$

where $A = \delta^{2\beta t} \exp(w - \gamma_1 (2/\pi)^{1/2}$

In this case, negative shocks have a larger effect on the conditional variance then positive shocks of the same size.

Vector Autoregressive (VAR) Model

Vector Autoregressive (VAR) model specifies every endogeneous variable as a function of the lagged values of endogeneous variables in the system. The VAR technique is very appropriate because of its ability to characterize the dynamic structure of the model as well as its ability to avoid imposing excessive identifying restrictions associated with different economic theories. That is to say that VAR does not require any explicit economic theory to estimate the model.

The use of VAR in macroeconomics has generated much empirical evidence, giving fundamental support to many economic theories (Blanchard and Watson, 1986) and Bernanke (1983), among others. Our unrestricted autoregressive VAR model in reduced form of order p is presented in the following equation,

$$Y_t = c + \sum A_i y_{t-i} + \varepsilon_t \quad (7)$$

where $c = (c_1, \ldots\ldots\ldots, c_{11})$ is the $(11X1)$ intercept vector of the VAR, *Ai* is the *ith* $(11X11)$ matrix of autoregressive coefficients for $i = 1,2,.........,p$ and is the (11X 1) generalization of a white noise process.

As described in the data section, we use seven endogenous macroeconomic variables in our system: *rop*, *bop*, *inf*, *gdp*, gex, *exch*, *une*and *intr*. The form of unrestricted VAR system in this study is thus given by:

$$\begin{bmatrix} roilp \\ bop \\ Inf \\ gdp \\ exch \\ gex \\ une \\ \text{int}\, r \\ rop+ \\ rop- \\ netrop \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \\ c_6 \\ c_7 \\ c_8 \\ c_9 \\ c_{10} \\ c_{11} \end{bmatrix} + A(l) \begin{bmatrix} roilp_{t-1} \\ bop_{t-1} \\ Inf_{t-1} \\ gdp_{t-1} \\ exch_{t-1} \\ gex_{t-1} \\ une_{t-1} \\ \text{int}\, r_{t-1} \\ rop+_{t-1} \\ rop-_{t-1} \\ netrop_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \\ \varepsilon_{7t} \\ \varepsilon_{8t} \\ \varepsilon_{9t} \\ \varepsilon_{10t} \\ \varepsilon_{11} \end{bmatrix}$$

where $A(l)$ is the lag polynomial operators, the error vectors are assumed to be mean zero, contemporaneously correlated, but not autocorrelated.

The unrestricted VAR system can be transformed into a moving average representation in order to analyze the system's response to a shock on real oil prices, which is:

$$y_t = \mu + \sum_{i=0}^{\infty} \psi_i \varepsilon_{t-i} \qquad (8)$$

with ψ_0 is the identity matrix and μ is the mean of process:

$$\mu = (I_p - \sum_{i=0}^{\infty} A_i)^{-1} c \qquad (9)$$

The application of moving average representation is to obtain the forecast error variance decomposition (VDC) and the impulse response functions (IRF). In this study, the innovations of current and past one-step ahead forecast errors would be orthogonalised using Cholesky decomposition so that the resulting covariance matrix is diagonal. This assumes that the first variable in a per-specified ordering has an immediate impact on all markets and variables in the system, excluding the first variable and so on. In fact, pre-specified ordering of markets and variables is important and can change the dynamics of a VAR system. In this analysis, we will use two different orderings. The first one is as follows: *rop*, *bop*, gex, *inf*, *intr*, *exch gdp* and *une*. For robustness test we shall make use of an alternative ordering which is based on VAR Granger Causality test as follow: *rop*, *intr*, *inf*, *gex*, *exch*, *gdp*, *une* and bop.

Empirical results

In this section, the estimation results of the EGARCH model, volatility persistence and asymmetric effect was explained. The volatility series obtained from the EGARCH estimates was evaluated by the VAR model.

Result of the VAR Model

The estimation of a VAR model firstly requires the explicit choice of lag length in the model. The appropriate lag length selection of the VAR is another important step. Too few lags mean that the regression residuals do not behave as white noise processes. The coefficients from the estimated VAR are not of primary interest in this empirical work since the individual coefficients are very difficult to be interpreted. Rather, we focus on the impulse response functions (IRFS) and variance decomposition (VDC) generated from the VAR.

Optimal Lag Length Selection and Stability Test

To determine the optimal lag length to use for our model, we employed five different lag order selection criteria (*LR*, *FPE*, *AIC*, *SIC*, *HQ*) to guide our decision. The essence of the battery of tests is for confirmatory analysis. We therefore selected different lag lengths for the different models based on the

Table 1. VAR lag length selection criteria results for oil price shocks

Model	LR	FPE	AIC	SIC	HQ	Chosen lag.
Roilprice	5	5	5	5	5	5
Roilprice+	5	5	5	5	5	5
Roilprice-	9	9	9	9	9	9
Netoilprice	9	9	9	9	9	9

Source: Authors' own computations.

Table 2a. VAR Granger Causality Test Result symmetric oil price

Direction of causality	F-Statistic	Probability	Decision
EXCH → ROP	3.80638	0.0532	Do not reject the null hypothesis
ROP → EXCH	8.40678	0.0044	Do not reject the null hypothesis
UNE → ROP	2.19012	0.1432	Do not reject the null hypothesis
ROP → UNE	4.14760	0.0437	Reject the null hypothesis
INF → ROP	2.58210	0.08995	Do not reject the null hypothesis
ROP → INF	0.00440	0.99561	Do not reject the null hypothesis
INTR → ROP	0.69398	0.4063	Do not reject the null hypothesis
ROP → INTR	4.07707	0.4455	Do not reject the null hypothesis
GEX → ROP	1.20054	0.2752	Do not reject the null hypothesis
ROP → GEX	5.10650	0.0255	Reject the null hypothesis
GDP → ROP	0.75227	0.3873	Reject the null hypothesis
ROP → GDP	8.25932	0.0047	Do not reject the null hypothesis
BOP → ROP	0.76596	0.65318	Do not reject the null hypothesis
ROP → BOP	1.24685	0.89616	Do not reject the null hypothesis

results obtained from the VAR lag length selection criteria: Likelihood Ratio (LR); Final Prediction Error (FPE); Akaike Information Criterion (AIC); Schwarz Information Criterion (SIC) and Hannan-Quinn Information Criterion (HQ). Table 1 shows the VAR lag length selection criteria results.

The Granger Causality Test Result

To analyse the statistical causality link between oil price shocks and the selected variables, we performed bivariate Granger Causality Tests. The Granger (1969), approach assesses whether past information on one variable helps in the prediction of the outcome of some other variable, given past information on the latter. It is important to note that the statement "x Granger causes y" does not imply that y is the effect or the result of x. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term

.

Table 2a, indicates the null hypothesis that symmetric oil price shocks does not Granger cause Interest rate, Real output and government expenditure in the country is rejected at 5 percent. However, we accept the null hypothesis that in Nigeria for the period under review, symmetric oil price does not Granger cause rate of inflation, exchange rate, unemployment rate and balance of payment. The result also reveals that oil price shock Granger causes real output, government spending and interest rate.

Table 2b shows the pair wise granger causality test result between asymmetric oil price and the selected macroeconomic variables. From Table 2b, we conclude that there is a unidirectional relationship between net oil price and exchange rate. That is, net oil price (NETROP) does not granger causes exchange rate rather it is exchange rate that granger causes net oil price. Also, exchange rate granger causes rise in oil price and itself granger cause by fall in oil price.

There is no causal relationship between net oil price, positive oil price with other macroeconomic variables (i.e. real output, unemployment rate, interest rate, government expenditure, balance of payment and inflation rate). Finally the null hypothesis that negative oil price does not granger cause real output, inflation rate, unemployment rate, balance of payment and interest rate is accepted at 5 per cent levels.

Impulse Response Function (IRFS)

In this section, the response of the selected macroeconomic indicators to fluctuations in oil price is reassessed. Since according to Sims, most estimated coefficients from VAR model are not statistically significant. Therefore, the impulse response functions and variance decompositions are further examined. Impulse response functions are dynamic simulations showing the response of an endogenous variable over time to a given shock. That is, it helps in tracking the contemporaneous and future paths of the key response variables to a one standard deviation increase in the current value of the stimulus variable.

Table 2b. VAR Granger Causality Test Result asymmetric oil price

Direction of causality	F-Statistic	Probability	Decision
EXCH → NETROP NETROP → EXCH	8.28215 1.38953	0.0047 0.2406	Do not reject the null hypothesis Do not reject the null hypothesis
UNE → NETROP NETROP → UNE	1.74147 1.72047	0.1892 0.1919	Do not reject the null hypothesis Reject the null hypothesis
INF → NETROP NETROP → INF	1.82857 0.29400	0.1786 0.5886	Do not reject the null hypothesis Do not reject the null hypothesis
INTR → NETROP NETROP → INTR	0.25423 0.25360	0.6150 0.6154	Do not reject the null hypothesis Do not reject the null hypothesis
GEX → NETROP NETROP → GEX	0.02020 0.31384	0.8872 0.5763	Do not reject the null hypothesis Reject the null hypothesis
GDP → NETROP NETROP → GEX	0.12968 0.11121	0.7193 0.7393	Reject the null hypothesis Do not reject the null hypothesis
BOP → NETROP NETROP → BOP	0.66378 0.66397	0.4167 0.4273	Do not reject the null hypothesis Do not reject the null hypothesis
EXCH → ROP+ ROP+ → EXCH	8.28215 1.38953	0.0047 0.2406	Do not reject the null hypothesis Do not reject the null hypothesis
UNE → ROP+ ROP+ → UNE	1.74147 1.72047	0.1892 0.1919	Do not reject the null hypothesis Reject the null hypothesis
INF → ROP+ ROP+ → INF	1.36856 0.44483	0.2442 0.5060	Do not reject the null hypothesis Do not reject the null hypothesis
INTR → ROP+ ROP+ → INTR	0.05900 0.33794	0.8085 0.5620	Do not reject the null hypothesis Do not reject the null hypothesis
GEX → ROP+ ROP+ → GEX	0.00055 0.00497	0.9813 0.9439	Do not reject the null hypothesis Reject the null hypothesis
GDP → ROP+ ROP+ → GEX	0.05796 0.06230	0.8101 0.8033	Reject the null hypothesis Do not reject the null hypothesis
BOP → ROP- ROP- → BOP	0.72318 0.64492	0.3966 0.4234	Do not reject the null hypothesis Do not reject the null hypothesis
EXCH → ROP- ROP- → EXCH	0.00553 13.9072	0.9408 0.0003	Do not reject the null hypothesis Do not reject the null hypothesis
UNE → ROP- ROP- → UNE	0.11228 0.14075	0.7381 0.7081	Do not reject the null hypothesis Reject the null hypothesis
INF → ROP- ROP- → INF	1.34890 0.00202	0.2476 0.9642	Do not reject the null hypothesis Do not reject the null hypothesis
INTR → ROP- ROP- → INTR	0.05125 0.03043	0.8213 0.8618	Do not reject the null hypothesis Do not reject the null hypothesis
GEX → ROP- ROP- → GEX	0.19274 0.25556	0.7195 0.7401	Do not reject the null hypothesis Reject the null hypothesis
GDP → ROP- ROP- → GEX	0.19274 0.25556	0.6614 0.6140	Reject the null hypothesis Do not reject the null hypothesis
BOP → ROP- ROP- → BOP	0.51503 0.1.14682	0.4742 0.2862	Do not reject the null hypothesis Do not reject the null hypothesis

Thus, attempt is made to examine the effect of oil price shocks on the selected macroeconomic indicators using impulse response function for 12 periods. Here we considered the effect of oil price shocks on the selected macroeconomic variables by using orthogonalized impulse response functions with linear and non-linear (*SOP and NOPI*) oil price specifications in a basic VAR model. The essence of considering different specifications of oil price is to ascertain the robustness of our result on how the selected macroeconomic indicators respond to the fluctuations in oil price. In the specific case of this study, output growth, exchange rate, balance of payment, interest rate, government expenditure and inflation are the key response variables, while real oil price is the major forcing factor. In what ensues, therefore, impulse responses to the real oil price shocks derived from the standard Cholesky factorization for each of the macroeconomic indicator models are displayed and discussed in turn.

(a) Symmetric Effects

Figure 1 depicts statistical results of orthogonal impulse response of symmetric oil price shocks on the selected macroeconomic variables for a year (12 months) forecast horizon. The shocks in real oil price slightly reduced real government expenditure for the first six periods but became

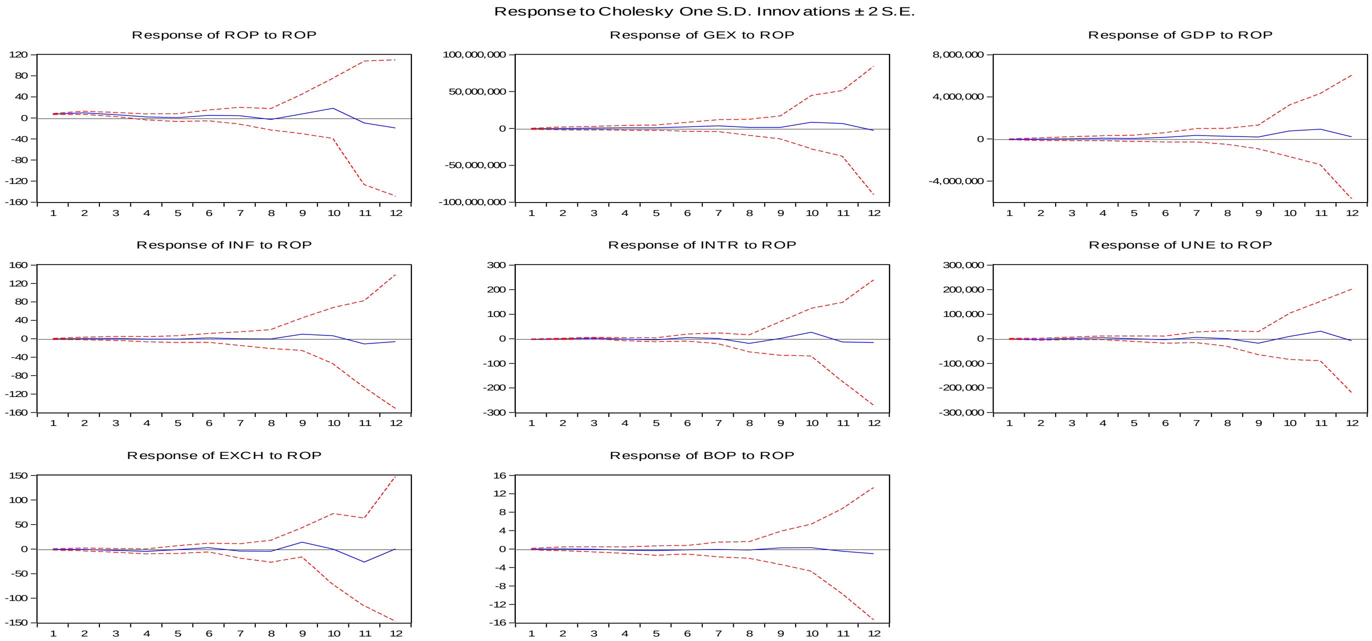

Figure 1: Orthogonalized impulse response function of selected macroeconomic variables to oil price shocks (ROP:linear specification gdp, gex inf, intr, exch, une and bop)

marginally positive in the last three periods. The slight but steady falls in real government expenditure therefore reduced the general price level significantly for the first eight periods. However, shocks in real oil price significantly increased real GDP, interest rate and real effective exchange rate for the first three periods after initial shock; although these variables fell slightly before rising mildly for real GDP from the fifth to the twelfth periods, positive but insignificant for interest rate from sixth to twelfth period, and positively insignificant for real effective exchange rate from fourth to twelfth periods. Balance of payment responds in positively insignificant manner after initial shocks in oil price all through the time horizon, thereafter volume of import rises moderately in the medium and long term. Unemployment rate responds was flat in an insignificant manner in the first seven periods and thereafter responded a positively insignificant fashion to shocks in oil price. The reverse reaction to shocks in oil price by real government expenditure and real GDP suggests that growth motivating forces lies outside government expenditure, such forces seems likely to have neutral effect on general price levels. Taking into cognizance the frequent adjustments in Nigerian fiscal framework in response to prevailing economic situation in the period covered, budgetary operations thus, became a function of different factors, and are designed to achieve specific objectives across different political regimes (Akinley et al. 2013). Reduction in real government expenditures and the corresponding ease in inflation, therefore reflect the effect of reflationary budget usually implemented by the Executive arm of government through the Federal Ministry of Finance and the Budget Office, in periods of oil price growth as witnessed during the Gulf war. Conversely, short run rise in real GDP, interest rate and real effective exchange rate, would be traced to the corresponding effects of contractionary monetary policy designed by the Central Bank of Nigeria (CBN) to achieve macroeconomic stabilization objectives, through upward review of benchmark interest rate, liquidity ratio and devaluation of local currency, so as to reduce the adverse effect of oil price growth. Medium and long-run reactions also reflect appropriate adjustments in policy mix (fiscal and monetary) in accordance to prevailing political and economic conditions.

(b) Asymmetry Impact of Oil Price

As part of the objectives, the Impulse response functions of the asymmetric impact of oil price are considered in this section. Figures 2a to 2g reveal the impulse response of an asymmetric impact of oil prices on output, inflation, balance of payment, government expenditure, exchange rate, interest rate and unemployment rate. The figure shows a significant positive response of GDP to increase in oil price after the first two months all through the year. For response to net oil price, the figure displayed a negative response of GDP in the first four months but thereafter, responds positively all through the time horizon. On the response of GDP to decrease in oil price, it showed a positive response all through the period. These findings are consistent with that of Lee, Ni and Ratti (1995) for GNP growth in the US and Jimenz-Rodriguez and Sanchez, (2005) for France, Italy, Norway and Canada.

Figure 2b depicts the response of government expenditure to asymmetric oil price shock. The results suggest that rising oil price has positive effects on government expenditure especially after the first month. The response of government expenditure to net oil price is negative for the first four months but became positive after the fourth month. Government expenditure responded positively to oil price increase as indicated in the figure especially after two months. On the response to decrease in oil price, it also responded positively. The results obtained with respect to real government expenditure and output thus

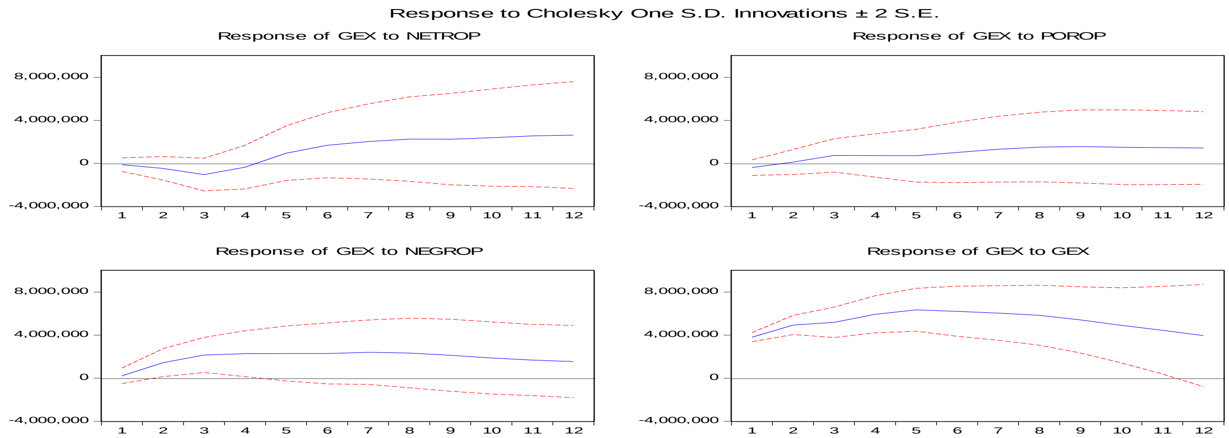

Figure 2b: Orthogonalized impulse response function of GEX to asymmetric oil price shocks (ROP+, ROP-, NetROP: Nonlinear specificationGEX)

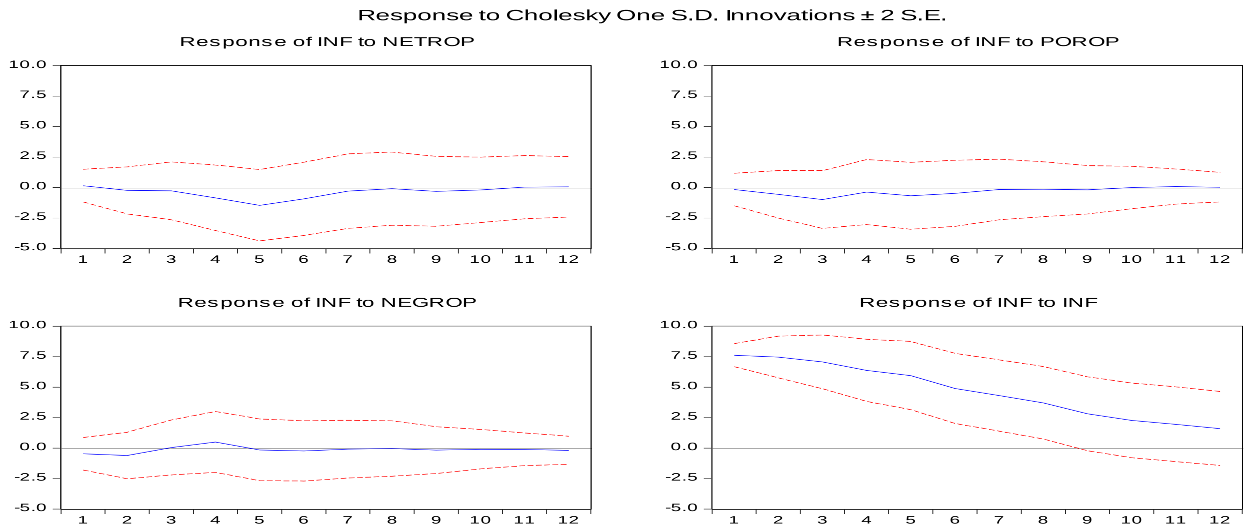

Figure 2c: Orthogonalized impulse response function of INF to asymmetric oil price shocks (ROP+, ROP-, NetROP: Nonlinear specification INF)

reflect the dominant influence of public sector spending in overall economic activities, as efforts to ensure macroeconomic stability through effective coordination of fiscal and monetary policy prevent immediate monetization of oil proceeds through increased public spending, which therefore kept growth at modest levels.

On the response to own shock, the Nigerian inflation rate shown an inverse relationship with time. That is the inflation rate is decreasing with passage of time. Inflation rate responds negatively to both increase in oil price and the net oil price all through the time horizon as shown in Figure 2c. Inflation did not respond to shocks to oil prices in all the 12 months period after the occurrence of such a shock.The inflation rate responded negatively in the first three months and thereafter appear insignificant to decrease in oil price shocks. The general price level falls significantly from the third to seventh quarters to show that the Nigerian economy does not suffer from the usual inflationary pressures associated with positive changes in oil prices in the short run. This was made possible by policy response in the form of monetary tightening stance which effectively tamed growth in broad money supply in the medium and long-run.

The statistically significant drop in long-run trend of inflation rate could further be attributed to slight increase in import volumes coupled with the monetary tightening policy effects.

A cursory inspection of the impulse responses reported in Figures 2d showed that the interest rate is insignificant to its own shocks all through the period and the asymmetric oil price shocks for the time horizon of 12 month period. This conveys the reaction of interest rate to effective liquidity tightening measures by the monetary authority mostly through increase in benchmark interest rate.

Figure 2e also shows the response of unemployment rate to asymmetric oil price shocks in Nigeria. A closer look at the figure reveals that unemployment rate responses positively to its own shocks but the positive response decreases with time. Unemployment rate respond positively to the net oil price shocks, increase in oil price as well as decrease to oil price shocks.

Using a response period of 12 months, the Figure 2f also shows that balance of payment response positively to its own shocks but decreased as time progresses. Balance of payment responses initially positive to oil price increase shock but after

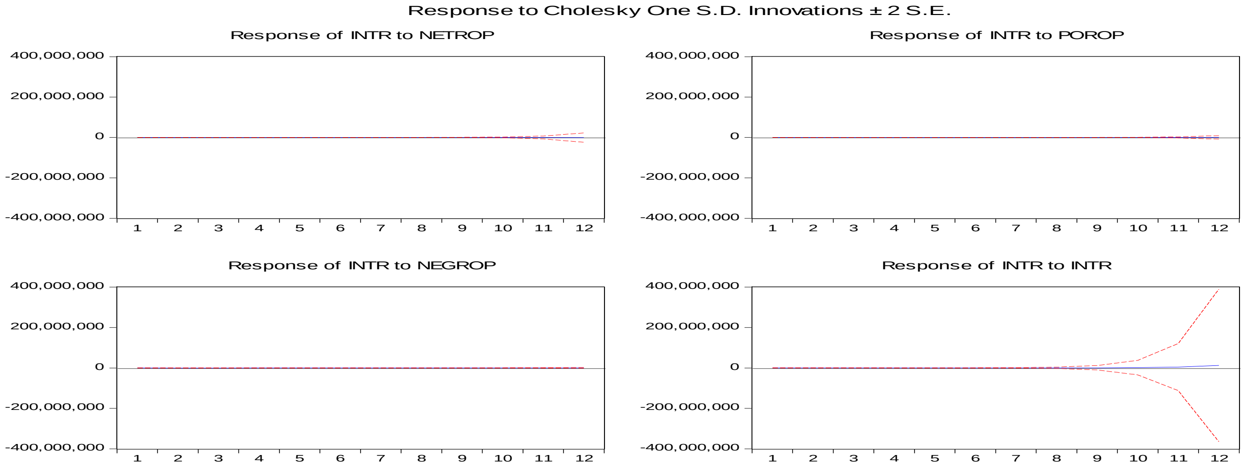

Figure 2d: Orthogonalized impulse response function of INTR to asymmetric oil price shocks (ROP+, ROP-, NetROP: Nonlinear specification INTR)

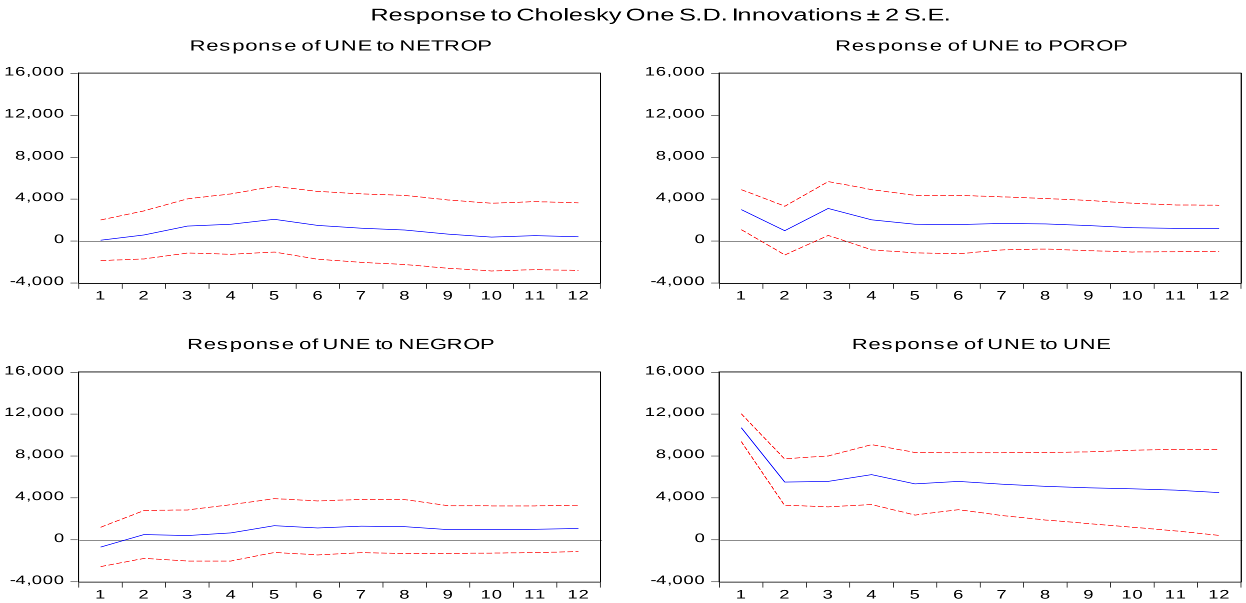

Figure 2e: Orthogonalized impulse response function of UNE to asymmetric oil price shocks (ROP+, ROP-, NetROP: Nonlinear specification UNE)

half of the year, it response negatively. A further observation shows that the balance of payment hovered within the horizon for the protracted period. On net oil price shocks, it responded negatively all through the time horizon. The balance of payment response positively to decrease in oil price shocks.

Finally, Figure 2g display the impulse response of exchange rate to asymmetric oil price shocks for a period 12 months. The figure shows that exchange rate response positively to its own shocks. Real effective exchange rate jumped sharply in the first three quarters in response to positive changes in oil price, slows down in the medium to long term but was consistently significant throughout the periods to suggest the downside risk to the country's currency on increase oil price, particularly following the liberalization of the Nigerian foreign exchange market as part of the broad financial sector reforms programme of SAP.It responds negatively to both a fall and rise in oil price shocks all through the period. The response to net oil price shocks is negative in the first four months but positive after the fourth month till the end of the period.

Variance Decomposition

Variance decompositions are presented in Tables 3a and 3b following our different oil price specifications. The essence of the variance decomposition is to show the proportion of the forecast error variance of a variable that is attributable to its own innovations and other variables, including oil price as the impulse response functions basically analyze the qualitative response of the variables in the system to shocks in real oil prices.The results presented in Table 3a accounts for the variance decompositions of the different variables attributable to oil shocks for four quarterly periods under symmetric specification while in Table 3b, we have the variance decomposition of the variables with asymmetric specification for four quarterly period.

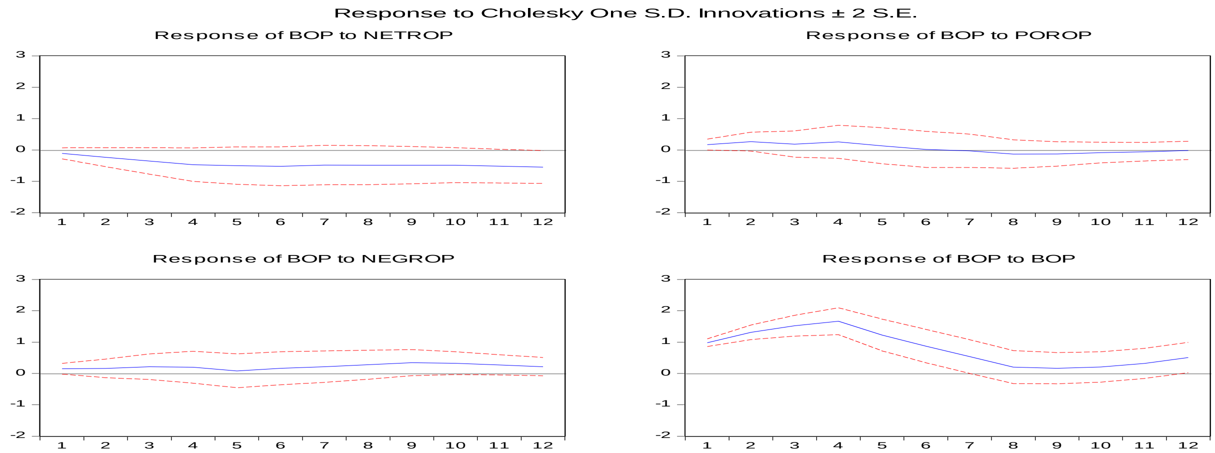

Figure 2f: Orthogonalized impulse response function of BOP to asymmetric oil price shocks (ROP+, ROP-, NetROP: Nonlinear specification BOP)

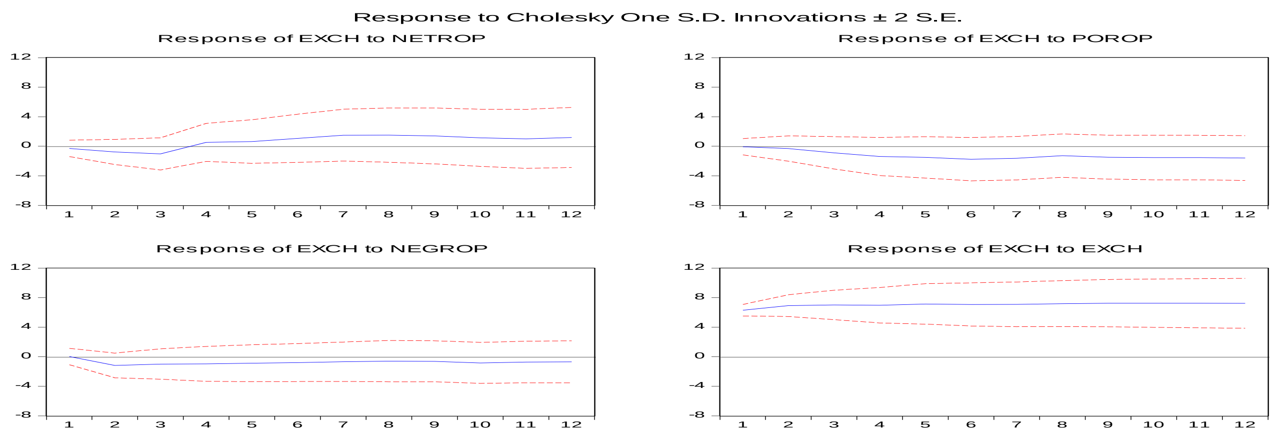

Figure 2g: Orthogonalized impulse response function of EXCH to asymmetric oil price shocks (ROP+, ROP-, NetROP: Nonlinear specification EXCH)

(a) *Symmetric Effects*

Table 3a demonstrates the variance decompositions of the VAR model in symmetry definition of oil price shock on the selected macroeconomic variables attributable to real oil price shocks. Oil price growth stimulates the volatility of the other variables in the model to varying degrees. Oil price shocks strongly accounts for 97.3 per cent of its own shock in the first quarter, while interest accounts for more than half of the remaining percentage of decomposition in real oil price shocks. In the second quarter, real oil price maintained an average of 76.1 per cent of own innovation while for the fourth quarter, it accounts for only six per cent of own shocks while real output alone accounts for over 82 per cent of variation in real oil price.

Fluctuations in the country's BOP strongly accounts for its own fluctuation in the first three quarters, while real GDP explains 80 per cent of fluctuation in BOP in the last quarter. However, real oil price accounted for 1.6 per cent of decomposition in BOP in the second quarter excluding its own shocks. Oil price also accounts for 1.8 per cent and 0.9 per cent for third and fourth quarters respectively. The implication is that the effect of real oil price on BOP is insignificant at the medium and long term periods. Fluctuations in effective exchange rate emanates from its own shocks between the first and second quarter except for the fourth quarter where real GDP proves strong again by accounting for over 79 per cent of fluctuations in effective exchange rate in the fourth quarter of the period under consideration. Oil price accounts for between 2.67 to 12.86 per cent throughout the periods. Oil price shows a significant impact at the medium term period.

Real GDP solely and strongly accounts for its fluctuation through the period with oil price shocks having 0.85 per cent in the first quarter, 1.03 per cent in the second quarter, 3.84 per cent and 6.53 per cent during third and fourth quarters respectively. This shows that the effect of real oil price on real GDP is gaining momentum in the process of time. Surprisingly, fluctuations in real government expenditure is insignificant of own shocks for the four quarters under consideration. Rather, Real GDP proves strong account for fluctuations in real government expenditure all through the period under consideration. Oil price accounts for 5.99 per cent in the third quarter and 5.32 per cent during the last quarter.

The variance decomposition of inflation rate from the above table reveals that inflation shocks contribute 84.14 per cent and 73.42 per cent of own shocks in the first and second quarters. However in the long run, especially at the fourth quarter, it contributes only little to own variations (0.95%). Real GDP solely and strongly accounts for 90 per cent of fluctuation in inflation rate during the fourth quarter with oil price shocks

Table 3a. Variance decomposition for symmetry effects

	Variance decomposition of ROP								
Quarter	**S.E**	**ROP**	**BOP**	**EXCH**	**GDP**	**GEX**	**INF**	**INTR**	**UNE**
1	11.2024	97.3555	0.0065	0.0482	0.2232	0.7209	0.0355	1.4984	0.1118
2	16.2372	76.1807	0.2440	0.5398	3.0708	14.3724	0.5640	4.5665	0.4617
3	25.7648	45.8761	0.7911	0.9203	20.6305	24.5234	1.1962	5.5227	0.5397
4	116.9555	6.0737	0.6637	0.5286	82.2502	7.4560	0.0618	2.8986	0.0673
	Variance decomposition of BOP								
Quarter	**S.E**	**ROP**	**BOP**	**EXCH**	**GDP**	**GEX**	**INF**	**INTR**	**UNE**
1	1.4518	0.1045	95.1941	0.3419	0.9297	0.9563	0.1735	0.7812	1.5188
2	2.8230	1.6266	80.5486	2.6934	7.6226	0.7196	0.6881	0.7018	5.3992
3	3.6522	1.8346	54.9980	4.5825	29.5124	1.4378	0.7493	2.4427	4.4427
4	8.7960	0.9914	10.6594	1.2509	80.5649	2.1894	0.5948	2.3313	1.4179
	Variance decomposition of EXCH								
Quarter	**S.E**	**ROP**	**BOP**	**EXCH**	**GDP**	**GEX**	**INF**	**INTR**	**UNE**
1	9.1385	2.6781	3.9705	75.8481	0.7964	9.1956	0.0731	7.2176	0.2207
2	16.3193	12.7639	6.9081	45.2868	0.8290	25.7039	0.0611	7.3355	1.1117
3	38.1323	10.9763	4.6931	22.2681	26.9701	28.1615	0.1832	5.7141	1.0336
4	122.6002	4.6469	1.0496	1.9289	79.0783	9.6869	0.0921	3.4244	0.0928
	Variance decomposition of GDP								
Quarter	**S.E**	**ROP**	**BOP**	**EXCH**	**GDP**	**GEX**	**INF**	**INTR**	**UNE**
1	4988849.47	0.8527	0.3171	0.3519	97.4810	0.6437	0.0008	0.3503	0.0026
2	119970000	1.0334	2.6974	0.6097	89.3462	2.4187	0.0277	3.7902	0.0768
3	233190000	3.8434	3.4668	1.0544	72.8718	6.8193	0.1461	11.6915	0.1067
4	5.02786000	6.5350	2.2175	0.5388	70.2374	9.4180	0.1560	10.7302	0.1671
	Variance decomposition of GEX								
Quarter	**S.E**	**ROP**	**BOP**	**EXCH**	**GDP**	**GEX**	**INF**	**INTR**	**UNE**
1	638716	0.8724	0.4546	0.2508	96.8397	1.1180	0.0008	0.4588	0.0049
2	117980000	2.0347	3.5086	0.5232	84.6612	4.1713	0.0463	4.8967	0.1581
3	193680000	5.9922	3.8408	1.0924	61.8721	11.2988	0.2375	15.3582	0.3079
4	603260000	5.3214	1.1021	0.4322	78.0467	8.3920	0.1003	6.4376	0.1657
	Variance decomposition of INF								
Quarter	**S.E**	**ROP**	**BOP**	**EXCH**	**GDP**	**GEX**	**INF**	**INTR**	**UNE**
1	9.6739	0.4308	5.4219	0.1880	0.5866	3.9648	84.1492	5.1464	0.1123
2	13.3664	1.7001	4.3729	1.7000	2.5991	7.5741	73.4247	7.6204	1.0088
3	25.7500	3.3553	3.1310	1.1773	31.7959	9.6195	41.9303	6.8895	2.1012
4	131.8412	1.4720	0.4999	0.4839	90.9643	3.0808	0.9767	2.4425	0.0798
	Variance decomposition of INTR								
Quarter	**S.E**	**ROP**	**BOP**	**EXCH**	**GDP**	**GEX**	**INF**	**INTR**	**UNE**
1	7.3168	10.7574	3.7032	0.7278	2.9224	37.8115	0.0245	43.4990	0.5543
2	14.6810	15.1610	2.5493	0.8532	5.3034	56.0880	0.0366	19.2453	0.7632
3	72.3420	8.3234	0.5834	0.6706	58.7197	26.3630	0.0126	4.8568	0.4705
4	220.4160	3.5840	1.4407	0.5496	84.4403	6.9270	0.0054	2.9881	0.0649
	Variance decomposition of UNE								
Quarter	**S.E**	**ROP**	**BOP**	**EXCH**	**GDP**	**GEX**	**INF**	**INTR**	**UNE**
1	11813.4007	1.90009	0.5883	0.3304	1.0122	9.5544	0.9535	11.0668	74.5937
2	16452.7567	10.2567	1.005	0.9864	1.9320	26.5886	1.5720	15.9228	41.7365
3	44376.74	9.9149	0.5445	0.7199	31.5558	28.3653	0.6526	14.2801	13.9666
4	12437.73	7.1231	1.4096	0.2340	70.2285	14.171	0.0679	5.4033	0.8152

Source: Author's computation

having between 0.43 per cent and 3.35 per cent for the period. For fluctuations in interest rate, its accounts for 43.4 per cent of own shocks in the first quarter while real GDP and real government expenditure jointly explains 61.3 per cent and 85.08 per cent in the second and third quarters respectively. However, oil price accounts for 10.7 per cent in the first quarter and 15.1 per cent in the second quarter. Finally, unemployment rate shows strong accounts for its own shocks in the first quarter as it accounts for 74.5 per cent of own variation. Real government expenditure and real GDP jointly accounts about 60 per cent of fluctuations in the rate of unemployment in the country. Oil price shocks relatively accounts for variations in

Table 3b. Variance Decomposition for Asymmetry effects

Quarter	S.E.	NETROP	ROP+	ROP-	BOP
Variance decomposition of BOP					BOP
1	3.646031	2.299399	2.941128	1.854928	92.90455
2	3.87726	6.475135	2.152915	1.459632	89.91232
3	3.970172	11.31871	1.933166	2.454106	84.29401
4	4.01219	15.70197	1.942855	4.259888	78.05093
Variance decomposition of INTR					INTR
1	3.158412	0.274468	0.051397	0.013371	99.66076
2	372.4402	0.399035	0.049081	0.000353	99.54951
3	16038.26	0.411387	0.051906	0.000344	99.53952
4	224861.8	0.412606	0.052122	0.000354	99.53458
Variance decomposition of INF					INF
1	3.626528	0.068671	0.383339	0.416038	99.13195
2	3.889990	1.028144	0.762656	0.366374	97.84282
3	3.975679	1.333509	0.734486	0.316498	97.61891
4	4.014882	1.290718	0.70272	0.310015	97.69655
Variance decomposition of GDP					GDP
1	3.623972	0.503793	0.494279	4.335381	94.66655
2	3.878874	0.85187	0.52967	10.95233	87.66613
3	3.978901	1.749205	1.124206	12.29023	84.83636
4	4.035433	4.684517	2.012051	12.86289	80.44055
Variance decomposition of GEX					GEX
1	3.538911	0.832116	0.823602	4.834618	93.50966
2	3.378372	1.724355	1.13828	10.52206	86.6152
3	3.929097	4.612924	2.183412	10.99648	82.20718
4	4.018419	7.624662	3.249723	10.78937	78.33625
Variance decomposition of EXCH					EXCH
1	3.517498	0.743731	0.254299	1.06502	97.93695
2	3.708833	1.071265	2.085811	1.620702	95.22222
3	3.785085	1.89216	13.060174	11.328837	73.71883
4	3.833336	2.117465	13.330349	11.204761	73.34743
Variance decomposition of UNE					UNE
1	3.623671	0.47518	7.80627	0.432105	91.28644
2	3.831722	2.978487	9.318817	1.019269	86.68343
3	3.928396	3.626263	8.865372	1.951508	85.55686
4	3.992068	3.219364	8.501897	2.303475	85.97527

Source: Author's computation

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unemployment rate in the short run with about 10.2 per cent but proved minimal with 9.9 percent in the long run. Other variables exhibit similar trend with oil price shock having less than 8 per cent influence in their variations over the fourth quarters.

(b) Asymmetric Effects

Table 3b shows the variance decompositions of the VAR models that captured the asymmetric effects of oil price shocks on the selected macroeconomic variables. Both oil price increases and decreases affect the volatility of the other variables in the model to varying degrees. For variations in BOP, both positive and negative oil price shocks had insignificant influence on balance of payment in the short and long run. Balance of payment maintained an average of 86 per cent throughout the period. The net oil price however accounts for 11.3 per cent of variation in Nigeria's balance of payment for the third quarter and 15.7 per cent for the fourth quarter.

The variance decomposition of interest rate also suggests that both positive and negative oil price shocks are insignificant in explaining fluctuations in interest rate. In most cases, if not at all times, the variable itself is the largest source of its own variation in succeeding periods. The combined share of the asymmetric oil price increase and decrease account for more than 10 per cent of the variance of the real GDP in Nigeria for second quarter. The table shows that a positive oil price shock is relatively less important than a negative oil price shock in explaining the variation in output. This holds for both the short and long run.This is also significant considering the fact that (Dotsey and Reid, 1992) found that oil prices explain between 5% and 6% of the variation in GNP, while (Brown and Yucel, 1999) show evidence that oil price shocks explain little of the variation in output. (Jimenez-Rodriguez and Sanchez, 2005)

Table 4. Summary Statistics of Volatility

Variable	ROP-	NETROP	ROP+	ROP	UNE	BOP	EXCH	GDP	GEX	INF	INTR
Mean	-2.23	1.66	2.37	53.22	39913	12.78	63.25	611264	5243267	20.72	17.18
Std. Dev.	6.12	3.67	4.16	29.52	19743	4.35	61.95	224227	1756781	16.38	63.80
Skewness	-7.49	3.51	2.67	0.74	0.36	0.65	0.32	4.51	3.86	1.59	11.45
Kurtosis	71.80	19.62	12.31	2.27	2.80	3.82	1.30	22.71	16.38	4.75	132.71
Jarque-Bera	28091	1845.76	652.4	15.55	3.133	13.40	18.83	2662.8	1352.99	74.36	98306.19
p-value	0.000	0.000	0.000	0.000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

estimates from the decomposition of the forecast error variance show that oil price shock account for 8 per cent of Germany's output variability, 9 per cent in the UK, and 5 per cent in Norway. This also confirms the findings of (Barsky and Kilian, 2004); and (Olomola, 2006) and that oil price shocks had marginal impact on output.The increase in oil price shock from the variance decomposition does not have any effect on changes in the inflation rate. On the variance decomposition of real government expenditure, both oil price increases and decreases affect the volatility of the other variables in the model to varying degrees. For real government expenditure (*GEX*), negative oil price shocks initially account for about 4.8 per cent of its variation in the first quarter, increasing to a share of 10.8 per cent in the fourth quarter after shock, while the positive oil price shocks account for an average of 2.1 per cent of changes in real government expenditure in the third and fourth quarter. However, the instant (after first quarter) impacts of positive oil shocks are lesser than the impact of negative oil price shocks. The variance decomposition shows that the response of real government expenditure to a one standard deviation shock to negative oil price changes was significantly different from zero.This result confirms the huge monetization of crude oil receipts and subsequent increase in real government expenditure as explained earlier. However, with the introduction of an oil stabilization fund by the central bank to save some part of oil windfalls, the picture may differ in future.This result agrees with the foundings of (Farzanegan and Markwardt, 2008) where positive oil shocks accounted for an insignificant variation in government revenue. The other important aspect of the non-linear oil shock can be seen in the effects on real effective exchange (*EXCH*) rate fluctuation. While the positive oil shocks play a marginal role on variations in this variable, the negative oil shocks have a significant share in the long run. Volatility of EXCH due to oil price fluctuations is accounted for 13 per cent. This finding is in line with previous studies that negative oil price shocks do significantly affects the real exchange rate (Amano and Van Norden, 1998a and 1998b). For variations in unemployment rate, both positive and negative oil price shocks explain more about changes in real effective exchange rate four quarters after shock, while the influence of positive shocks proves stronger than that of negative oil price shock in the long run.

Results of the EGARCH Models

This study employs the exponential GARCH model to investigate the volatility transmission of asymmetric oil price within the economy among the selected macroeconomic variables.In the first part of this section, descriptive statistics for all return series are presented.The summary statistics of the oil price series with the macroeconomic indicators are given in Table 4.This shows that the distribution, on average, is positively skewed relative to the normal distribution (0 for the normal distribution). The positive skewness is an indication of non-symmetric series. The kurtosis for all the variables are larger than 1. Skewness indicates non-normality, while the relatively large kurtosis suggests that distribution of the oil price and the selected monetary indicators are leptokurtic, signalling the necessity of a peaked distribution to describe this series. The Jarque-Bera normality test rejects the hypothesis of normality for ROP-, NETROP, ROP+, UNE, BOP, EXCH, GDP, GEX, INF, and INTR at 5% level of significance.

The leptokurtosis reflects the fact that the market is characterised by very frequent medium or large changes. These changes occur with greater frequency than what is predicted by the normal distribution. The empirical distribution confirms the presence of a non-constant variance or volatility clustering. This implies that volatility shocks today influence the expectation of volatility many periods in the future.

The results of estimating the EGARCH models for the ROP-, NETROP, ROP+, UNE, BOP, EXCH, GDP, GEX, INF, and INTR are presented in Tables 5 using the student-t EGARCH model which assumes the conditional distribution of oil price shocks and the selected macroeconomic indicators. As the oil price return series shows a strong departure from normality, all the models will be estimated with Student t as the conditional distribution for errors. The estimation will be done in such a way as to achieve convergence.

The results reveals that α in all the macroeconomic variables appear to be larger than 0.1, which implies that the volatility of oil price is sensitive to the macroeconomic variables in the whole period. The parameter β measures the persistence in conditional volatility irrespective of anything happening in the market. Besides the parameter of GDP, INF and GEX are all positive and relatively large, i.e. above 0.9, then volatility takes long time to die out following a crisis in the oil price market. Also, the leverage effects γ are almost negative and significant at 5% for GDP, GEX, INTR and UNE, which means that good news generates less volatility than bad news for Nigerian oil price market while BOP, INF and EXCH, positive innovations are more destabilizing than negative innovations in the oil price market.

Table 5. Empirical result of EGARCH Model

	BOP	GDP	GEX	INF	INTR	EXCH	UNE
C	15.91****	1112901.8*	-251327**	18.61***	12.11***	0.13	24372.1***
ROP	-0.09***	5987.6***	87675.1**	-0.05***	-0.004	0.76***	-282.60***
ROP+	-0.01	-368.85	-11724.8	-0.11**	-0.19	0.44	865.12
ROP-	0.09***	-1235.76	-37264.2**	0.02	-0.02	-0.21	-187.27
NETROP	0.13***	-8095.63**	-97887.8**	0.16	-0.26	-0.99	-1061.44
ω	-1.85***	-0.62	-0.88	-0.39	3.70***	-0.44	5.00
α	2.43***	1.97***	2.84***	0.82**	1.96***	1.63***	0.78**
γ	0.38	-0.61*	-1.26***	0.02	-0.82***	0.30	-0.04
β	0.72***	0.97***	0.97***	0.93***	-0.32***	0.86***	0.71***

Note :*, **, *** statistically significant at 10%, 5% and 1% significant level

CONCLUSION

Based on the empirical findings, it can be concluded that symmetry shocks to oil price significantly influence exchange rate, output, unemployment rate and government spending in the Nigerian economy while for the asymmetric specification, both positive and negative oil price granger causes exchange rate of the naira. However, negative oil price shocks have a stronger short and long run role for fluctuations in both real output and government expenditure, by contributing more than 10 per cent of variances in government expenditure in the medium to long run (eighth to twelfth quarter after shock) and more than 12 per cent of variances in real output during same period, compared to positive oil price shocks which contributed just 2 per cent and 3 per cent respectively. We therefore conclude that negative shocks to oil price influences both government expenditure and real output. But, positive rather than negative shocks to oil price explain more about variations in unemployment rate in the long run, while both positive and negative oil price shocks explain more about changes in real effective exchange rate four quarters after shock. Furthermore, only positive oil price shock explains fluctuation in the country's balance of payment in the short run while negative oil price proved influential in this regard in the long run. Finally, neither positive nor negative oil price shocks move interest rate.

Conflict of interest

Authors have none to declare

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