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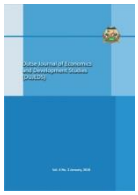

OIL PRICE SHOCK EFFECTS AND MACROECONOMIC PRICES IN NIGERIA

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Abstract
The objective of this paper is to empirically examine the impact of oil price shocks on macroeconomic prices in Nigeria, using an annual data for the period 1981 to 2015. The paper employed the vector autoregressive (VAR) model through the analysis of impulse response functions (IRFs) and variance decompositions (VDCs). The results reveal that macroeconomic prices namely, exchange rate, interest rate and inflation inversely do respond to oil price shocks and the impact is significant except on interest rate. The implication of the result is that shocks from oil prices have the potentials of causing significant changes in exchange rate and inflation in Nigeria while interest rate is not significantly determined by oil price shocks in the country. It recommends that the Nigerian authorities should devise a means for absorbing shocks in the event of blows from oil prices with regards to exchange rate and inflation by diversifying to nonoil exports that could generate more foreign exchange to the country.

Keywords: Shocks, Shocks Effect, Oil Price and Macroeconomic Prices
JEL Classifications:

Introduction

Crude oil is a publicly traded commodity and its price is determined through the interaction of demand and supply in the world commodity market, though, which has overtime fluctuates. Experience has shown that from time to time the price keep fluctuating abruptly and these vicissitudes from oil price results to significant changes in either the demand or supply-sides of the international market, this is what is called oil price shocks (Hamilton, 1983; Wakeford, 2006; Akpan, 2009). Therefore, oil price shocks can be traced from oil price index. Traditionally, oil shocks are more often traced to supply-side disruptions such as OPEC production quotas, political upheavals in major producing areas such as the Middle East and militant activities in the Niger Delta region of Nigeria (Akpan, 2009). Therefore, an oil price shock is a consequence of production disruption in oil producing economies leading to higher prices which triggers inflation and depression in the world economy. Naturally, the higher the oil price increase and the longer the higher prices are sustained, the bigger the macro-economic impact (Majidi, 2006 and Akpan, 2009) which results to some impediments to the economy. For instance, changes in the price of crude oil forces government to align its expenditures and programs in the direction of such changes and thereby, creating dilemma especially in the development of capital expenditures since it is entirely financed by oil revenues which constitute a major instrument that lubricates the smooth running of investment in a country. Traditionally, the price of crude oil has been more volatile when compared to other commodities or asset prices since the World War II. The trend of demand and supply coupled with the activity of OPEC consistently affects the price of oil. However, the consequences of oil price increase should be considered positive to exporting countries while the reverse should be expected when the oil price decreases, all things being equal. This shows

that Nigeria as one of the exporters of oil and the major player in the global oil arena as the six largest oil producing nation is vulnerable to oil price fluctuations which present the macro economy of the country to be fragile in nature which exert severe consequences to the economy. For instance, it triggered a huge decline in the country's revenue and foreign reserves, engendering a free fall of the currency regime and host of other implications. Thus, the effect of shocks from oil price to macroeconomic prices became an area of prime interest. Henceforth, the paper will empirically investigate the shocks effect of oil price on macroeconomic prices in Nigeria and will be from previous studies in scope as it entails recent oil price shocks and macroeconomic prices in Nigeria. Oil price shocks have a very strong consequence on economic activity as oil price shocks are often considered a bad news to a nation (Hamilton and Herrera, 2004). The prices of oil matter for an economy in several ways which could affect macroeconomic prices. This is because shocks in oil price directly affect foreign exchange, transportation costs, heating bills, and the prices of goods and services especially those directly made or their production depends on petroleum products.

Akinleye and Ekpo (2013) contended that an oil-price increase leads to a transfer of income from importing to exporting countries through a shift in the terms of trade which in turn could affect foreign exchange, domestic prices, expenditure, etc. However, the magnitude of the direct effect of a given price increase depends on the share of the cost of oil in the national income, the degree of dependence on imported oil and the ability of end-users to reduce their consumption and switch away from oil. Negative shocks in oil- exporting countries, lead to inflation, low foreign exchange, increased of input costs, lower investment, falls in tax revenue, decrease in budget which drives interest rates up. On the other hand, positive shocks in oil-exporting countries generates more foreign exchange, low domestic prices for those countries that relies much on import, and increase in budget which drives interest rate low. Taiwo and Patrick (2012) recounted that the oil price hike is a well-known cause of stagflation as mentioned in the macroeconomic literature, i.e. spikes in oil prices cause not only the higher price level, but also lead to drop in aggregate industrial output.

The main objectives of this paper are to identify the nature of the shocks effect of oil price on macroeconomic prices in Nigeria; to examine the impact of shocks from oil price on macroeconomic prices in Nigeria; and to offer recommendations based on the findings of the paper. The paper is organized into five sections. The first section gives introduction to the paper. The second section focuses on the review of the related literature, the third section discusses the methodology in which the objectives of the paper could be achieved, the fourth sections presents and analyzed the empirical findings of the paper while section five gives the conclusion and recommendations based on the findings of the paper.

Literature Review

A number of empirical works on the relationship between oil price fluctuations and economic activity have been carried out using different estimation approaches. Though their findings are helpful, yet there is a need to update them to meet the current dilemma in oil price fluctuations which is seriously affecting the economy of oil producing nations. Looking at the channel of transmission of oil price shocks to the larger economy, many researchers have argued that fluctuations in oil prices are linked to macro-economic performance. Notably, questions were raised with regards to the relationship between the price of oil and economic activity, which are fundamental empirical issues in macroeconomics, with the abundance of natural resources across the globe, particularly crude oil that is portrayed as a source of blessing to many nations, since its presence is used to spur economic growth. However, a considerable part of the available literature shows the adverse economic impact of oil price shocks on various macroeconomic variables in different nations.

Olomola and Adejumo (2006) examined the impact of oil price shocks on aggregate economic activity (output, inflation, real exchange rate and money supply) in Nigeria using quarterly data for the period 1970_{Q1} to 2003_{Q4} under VAR model. Their findings revealed that oil price shocks did not significantly affect output and inflation in Nigeria. However, it does influence the real exchange rate significantly. The authors argue that oil price shocks may give rise to wealth effect that appreciates the real exchange rate and may squeeze the tradable sector, giving rise to the "Dutch-Disease".

Akpan (2009) analyzed the dynamic relationship between oil price shocks and major macroeconomic variables (inflation, industrial production, exchange rate, public expenditure and real oil price) in Nigeria for the period 1970_{Q1}–2007_{Q4} using VAR model. The

result shows that positive and negative oil price shocks significantly increased inflation and also directly increased real national income through higher export earnings with a strong positive relationship between positive oil price changes and real government expenditures.

Mordi and Adebiyi (2010) examined the asymmetric effects of oil price shocks on output and prices (real GDP, consumer price index, aggregate money supply, deposit rate, real exchange rate, oil price asymmetry and all-share index) in Nigeria for the period $1999_{m1} - 2008_{m12,}$ using structural VAR model. The result reveals that the impact of oil price shocks on output and prices was asymmetric in nature, with price decreases significantly greater than oil price increases and on the variance decompositions oil price shocks played a significant role in determining the variations in output and prices.

Iwayemi and Fowowe (2010) analyzed the impact of oil price shocks on selected macroeconomic variables (real GDP, government expenditure, inflation, real exchange rate and net exports) in Nigeria for the period 1985:Q1 to 2007:Q4, using unrestricted VAR model. The result shows that different measures of linear and positive oil shocks had not caused output, government expenditure, inflation and the real exchange rate and they came to a conclusion that oil price shocks did not have a major impact on most macroeconomic variables in Nigeria.

Isah *et al*. (2015) investigate the impact of crude oil price shocks on some macroeconomic variables (crude oil shocks, exchange rate, external reserves, gross domestic product, inflation rate, international trade and money supply) in Nigeria for the period 2000_{Q1} to 2014_{Q4} using GARCH and VAR Models. The presence of heteroscedasticity was found in exchange rate with most of its coefficient being significant at 5% while crude oil shocks did not pose a significant inflationary threat to the Nigerian economy in the short run; rather, it improves the level of gross domestic product. However, external reserves and international trade were significantly affected due to the recent fall in crude oil export. Oil shocks also positively affect money supply, showing that monetary policy response to oil price changes and at the same time, money supply did affects gross domestic product.

Methodology

The data set for this paper consists of annual time series from 1981 to 2015. The variables under consideration are Oil Prices (OILP), Interest Rate (INT), Exchange Rate (EXR), and Inflation (INF). The oil price data were sourced from the Organization of Petroleum Exporting Countries (OPEC) statistical bulletin (2016) while data on interest rate, exchange rate and the inflation were sourced from the development indicators of the World Bank statistical bulletin (2016).

Estimation Technique

The principal estimation technique employed to analyze the time series behaviour of the data involves vector autoregressive model (VAR) through the analysis of impulse response functions (IRFs) and variance decompositions (VDCs). However, it is worthwhile to note that the goal of a VAR analysis is not to obtain parameter estimates but to assess empirical regularities in the data or dynamic interactions among the variables. Hence, in the VAR modeling, it is the overall stationarity of the VAR system and not the individual variables' stochastic properties that matters for the robustness of the VAR results (Lutkepohl, 2006). Similarly, Brooks (2014) resisted that to capture the dynamic responses of non-policy variables due to unexpected shocks, a VAR can be run whether the series are stationary or not and the fact that there is also a claim by many proponents of the VAR approach that differencing to induce stationarity should not be done in VAR estimate because they argue that the purpose of VAR estimation is purely to examine the relationships between the variables, and that differencing will throw information on any long-run relationships between the series away. Moreover, the goal of a VAR analysis is to determine the contemporaneous relationship among the variables not the parameters estimates, hence the stationarity or otherwise of the variables should not be bothered about. Hence, the current paper will run VAR at level.

A VAR model is an estimation technique popularized by Sims (1980). According to Sims (1980), the goal of the VAR analysis is to determine the interrelationship among variables in the system and not parameter estimates. Thus, the impulse response functions and variance decomposition tests, which are the main strength of VAR model, would be used to examine the interrelationships among the variables in the model. It provides a multivariate framework where changes in a particular variable are related to changes in its own lags and the lags of other variables (Koitsiwe *et al*, 2015). Farzanegan and Markwadt (2009) argued that the use of VAR model provides a framework for assessing the effects of a particular variable on other variables and because all variables

are considered as endogenous variables. The structural relationships are free of a priori restrictions.

The VAR model could simply be presented in equation (1):

$$Y_t = a + A_1 Y_t + \ldots + A_p Y_{t-p} + BZ_t + \varepsilon_t \quad (1)$$

Where Y_t is a vector of the endogenous variable, $\boldsymbol{a}$ is an intercept, Z_t is a vector of exogenous variables, A_1 and B are coefficient matrices, P is the lag length and ε_t is an unobservable zero-mean white noise. In a VAR model, the vectors of the endogenous variables are arranged according to the Cholesky decomposition. In this sequence, the variables that appear first are considered more exogenous while those appearing last are considered endogenous.

More specifically, the model which also incorporates the above direct and indirect linkages is presented in equation (2) through (5):

$$LOILP_t = \alpha_{it} + \sum_{j=1}^{n-1} \delta_{ij} LOILP_{t-j} + \sum_{j=1}^{n-1} \theta_{ij} INT_{t-j} + \sum_{j=1}^{n-1} \gamma_{ij} LEXR_{t-j} + \sum_{j=1}^{n-1} \Phi_{ij} INF_{t-j} + \varepsilon_{2t} \quad (2)$$

$$INT_t = \alpha_{it} + \sum_{j=1}^{n-1} \delta_{ij} LOILP_{t-j} + \sum_{j=1}^{n-1} \theta_{ij} INT_{t-j} + \sum_{j=1}^{n-1} \gamma_{ij} LEXR_{t-j} + \sum_{j=1}^{n-1} \Phi_{ij} INF_{t-j} + \varepsilon_{4t} \quad (3)$$

$$LEXR_t = \alpha_{it} + \sum_{j=1}^{n-1} \delta_{ij} LOILP_{t-j} + \sum_{j=1}^{n-1} \theta_{ij} INT_{t-j} + \sum_{j=1}^{n-1} \gamma_{ij} LEXR_{t-j} + \sum_{j=1}^{n-1} \Phi_{ij} INF_{t-j} + \varepsilon_{5t} \quad (4)$$

$$INF_t = \alpha_{it} + \sum_{j=1}^{n-1} \delta_{ij} LOILP_{t-j} + \sum_{j=1}^{n-1} \theta_{ij} INT_{t-j} + \sum_{j=1}^{n-1} \gamma_{ij} LEXR_{t-j} + \sum_{j=1}^{n-1} \Phi_{ij} INF_{t-j} + \varepsilon_{6t} \quad (5)$$

Where $\beta, \delta, \varphi, \theta, \gamma, \Phi$are the unknown parameters, α is the constant ε_{it} is the stochastic error term, *n* is the no of lags while LINV, LOILP, LSAV, INT, LEXR, INF are as defined above.

However, the choice of the estimation technique is as a result of the fact that the vector autoregressive model best captures the two-way relationship between oil price, investment and other variables using their related lags. A unique feature of the VAR model is that an endogenous variable in one equation of the system appears in another equation as an explanatory variable, thereby becoming stochastic and correlated with the disturbance term (Shock or impulse term) of the equation. Also, in a VAR model, variables are treated equally and no distinctions are made between endogenous and exogenous variables. Hence, the Ordinary Least Square (OLS) technique will appear to produce results that are inconsistent and bias.

Moreover, it is important to note that in a VAR model the coefficients cannot be interpreted directly but rather innovation accounting techniques are adopted to interpret the results and these are the Impulse Response Functions (IRFs) and the Variance Decompositions (VDCs). These techniques will help to unveil the nature of the feedback effects among the variables, which in effect will help to check for the robustness of the results and gain more insights on the complexity of the relationships (Shahbaz *et al*. 2014). The IRFs is a technique that determines the dynamic effect of each variable to shocks of others in a VAR system while the variance decomposition (VDC) analysis shows the contribution of the variance in the forecast error for each variable to shocks from all the variables in the VAR system (Enders, 1995).

Data Presentation and Analysis

In estimating a VAR model, it is always essential to determine the optimal lag length of it. According to the results of the Likelihood Ratio (LR), Final Prediction Error (FPE), Schwarz information criterion (SC) test and Hannan-Quinn Information Criterion (HQ), the optimal lag length of the VAR model was decided to be one for the model (See Table 1).

Table 1: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-312.7002	NA	2546.606	19.19395	19.37535	19.25498
1	-209.5880	174.9782	13.09620	13.91442	14.82140*	14.21959
2	-188.1449	31.18995*	9.871750*	13.58454*	15.21709	14.13385*

Source: Researchers Estimation output using E-views 9.5
* indicates lag order selected by the criterion and each test at 5% level

Table 1 reported the lag order selection criteria. The majority of the criterion proposed 2 lags as the appropriate lag order for the VAR model to be estimated.

The next step is selecting the deterministic terms in VAR. Since most macro-economic data exhibit a linear trend (and not a quadratic one), which can be captured by an intercept, we select an intercept in the VAR.

After the estimation of the VAR model the stability of the model has to be checked. Normally, the modulus and the inverse roots of the model are used to test for the stability and therefore the overall stationarity of the model. Table 2 and Figure 1 as the modulus and the inverse roots respectively shows that all the modulus in the table are less than one and all the roots of characteristic polynomial lay within the unit circle. This indicates that the two-lag VAR model satisfy the stability condition.

Table 2: Modulus of the Estimated VAR Model

Root	Modulus
0.902173 - 0.042273i	0.903163
0.902173 + 0.042273i	0.903163
0.627314	0.627314
0.225257	0.225257

Source: Researchers Computation, 2017 (E-views 9.5)

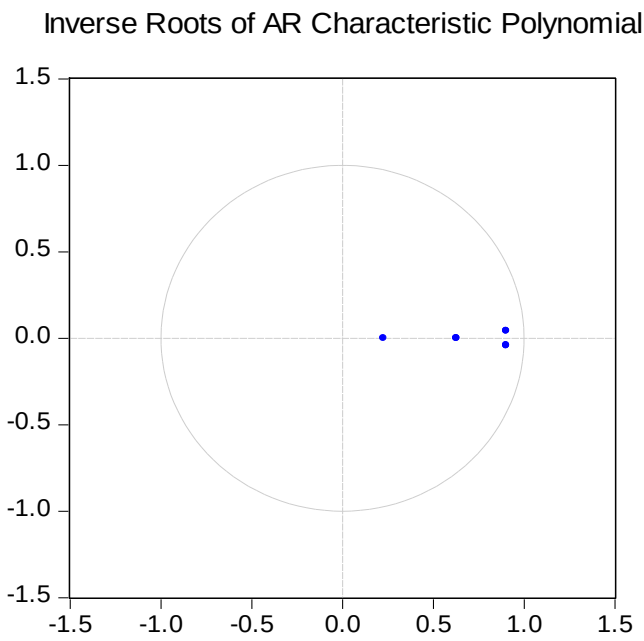

Fig 1: Inverse Roots of AR Characteristic Polynomial
Source: Researchers' Computation (E-views 9.5)

From Table 2 all the modulus are less than one and in Figure 1 none of the roots lies outside of the unit circle, hence it can be conclude that the VAR estimates satisfy the stability condition, hence the model satisfies the overall stationarity of the model.

The Impulse Response Functions (IRFs)

The analysis of the impulse response functions in this paper focused on the impact of oil price shocks on macroeconomic prices namely, exchange rate, interest rate, and inflation in Nigeria occasioned by the need to examine the relationship between them. However, aim of using the impulse response functions is to trace the time path of the structural shocks in the VAR system. The two famous frameworks commonly employed are the cholesky decomposition and the generalized impulse response function. The former is often criticized, because of its sensitivity to the ordering of the variables in the system. The paper, therefore, adopts the generalized impulse response function (GIRF), a method that is invariant to the ordering of the variables in the VAR system.

Figure 2 shows the responses of exchange rate, interest rate, and inflation as a result of oil price shocks over a 10year horizon.

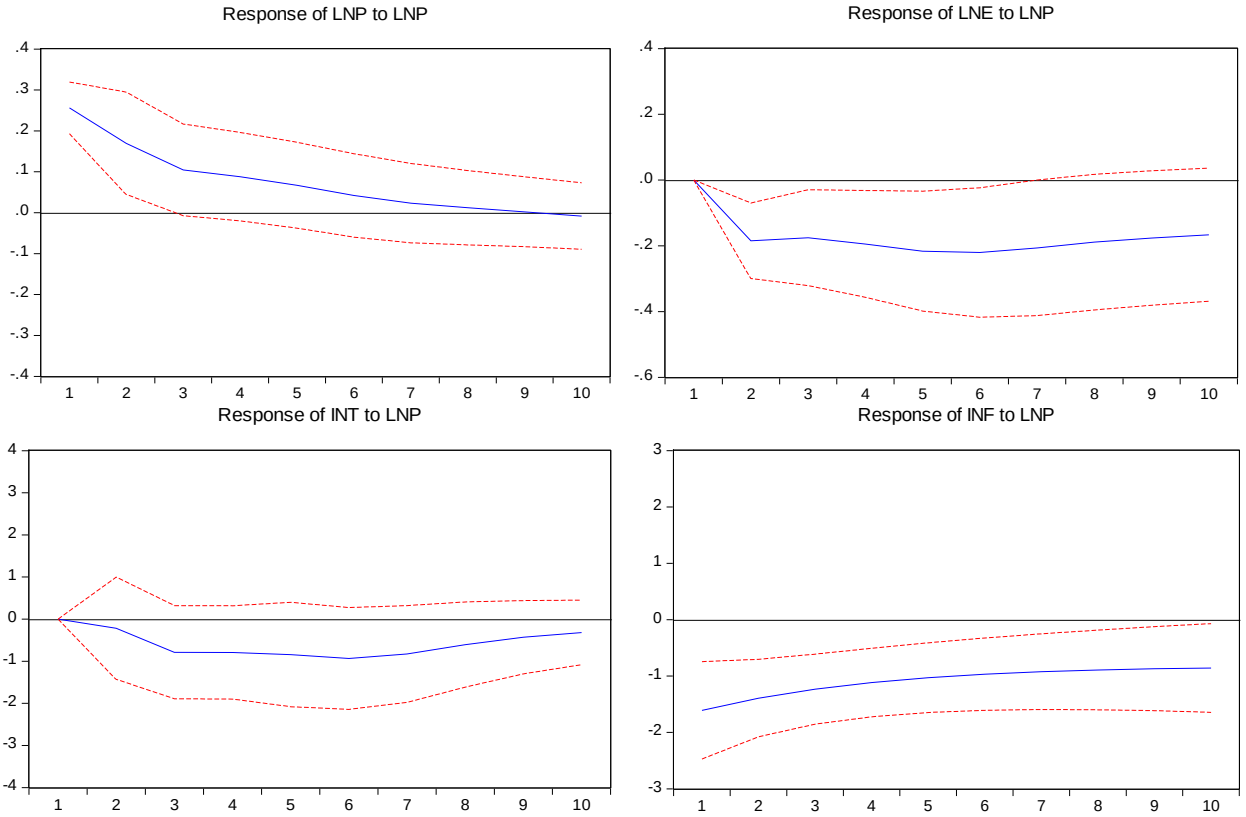

Figure 2: Generalized Impulse Response Function
Source: Researchers Computation (E-views 9.5)

Variance Decomposition Analysis

Exchange rate responds negatively to the shocks in oil price throughout the 10years horizon and right from the 1st up to the 8th year is statistically significant. Therefore, positive shocks from oil prices lower exchange rate in Nigeria and vice-versa. This revealed that oil price fluctuations significantly determine the level of exchange rate in Nigeria, with the fact that Nigeria is an exporter of crude oil whom its volume of foreign exchange largely depend on it. Hence, in Nigeria, oil price increase leads to appreciation of the naira, which is in line with the priori expectation and this confirms the findings of Berument, et al (2009) that the currency appreciates significantly for Oman and the UAE (which are net oil exporting countries) when oil price is increased. Therefore, the higher the oil price the higher the volume of foreign exchange and the lower the exchange rate of dollar to naira in Nigeria as confirmed by this paper. However, Charles *et al.* (2010) contended that one needs to be cautious in interpreting the exchange rate effects of oil price shocks because the effect may depend on the exchange rate regime, and the willingness of central bank to use their exchange reserves for a share of oil during international trade transactions. In addition, even though oil price increases result in exchange rate depreciation, the depreciation in exchange rate

arising from oil price increase is less than that of oil price decrease. Likewise, the foreign exchange may be scarce and thus causing high exchange rate of dollar to naira due to some factors other than negative shocks from oil prices such as looting of oil proceeds by government officials during the booming period that could save to use in rainy day.

Interest rate responds negatively to oil price changes throughout the horizon but is statistically insignificant because the horizontal line in the IRFs falls between the confidence interval. Hence, sudden changes in oil prices do not directly determine the level of interest rate in Nigeria.

Inflation, like other macroeconomic prices in the analysis responds negatively to oil price changes over the horizon of 10years but unlike interest rate, the effect of oil price shocks on inflation is statistically significant throughout the 10years horizon and this satisfy the a prior expectation that Nigeria is an importer of essential commodities which the importation of such products depends on availability of foreign exchange, definitely the consumer price index in the country must be affected by the oil price fluctuations since the availability of foreign exchange in the county depends on oil proceeds. But as the previous discussion under the effect of oil price shocks on exchange rate, it is not only the change in price of oil that causes scarcity of foreign exchange but also the willingness of central bank to use their exchange reserves for a share of oil during international trade transactions and looting of oil proceeds by government officials during the flourishing period of oil sales.

The results of the variance decomposition reported in Table 3 shows the contribution of each variable to its own shock and to another in explaining the proportion of forecast error variance over a 10year horizon. Therefore, the variance decomposition provides the proportion of movement in a specific variable in connection with its own shock against the shocks to other variables. In practice, its own-series shock explains most parts of forecast error variance of variables and that the higher the share of explanation of error variance, the more important that variable is for the other variables in the system.

Table 3: Variance Decomposition

Variance Decomposition Position of LNP

Period	S.E.	LNP	LNE	INT	INF
1	0.255748	100.0000	0.000000	0.000000	0.000000
5	0.420555	84.77451	2.252763	11.10962	1.863112
10	0.479300	**70.10153**	17.179101	3.52323	9.196137

Variance Decomposition Position of LNE

Period	S.E.	LNP	LNE	INT	INF
1	0.265919	0.395869	99.60413	0.000000	0.000000
5	0.680961	10.46572	66.37260	7.587305	15.57437
10	0.947522	15.05622	**53.29175**	8.490807	23.16122

Variance Decomposition Position of INT

Period	S.E.	LNP	LNE	INT	INF
1	2.861335	2.507956	6.802557	90.68949	0.000000
5	3.974072	26.69735	8.904838	63.34860	1.049216
10	4.319934	4.65803	8.121121	**55.14522**	32.075630

Variance Decomposition Position of INF

Period	S.E.	LNP	LNE	INT	INF
1	14.60386	3.071571	0.089929	3.762745	93.07575
5	17.82138	7.508415	0.071449	13.46449	78.95565
10	18.32527	19.611573	13.474944	15.03551	**51.87797**

Source: Researchers Computation (E-views 9.5)

The results of the variance decomposition reported in Table 3 shows the contribution of each variable to its own shock in explaining the proportion of forecast error variance at the end of the 10 years horizon. In terms of each variable's own shock, the results indicate that oil price shocks has the highest power of explaining itself by 70% in the VAR system over the horizon of 10years while exchange rate (LNE), interest rate (INT), and inflation (INF) account for 17%, 3%, and 9%, respectively. The variance decomposition of exchange rate (LNE) indicates that 53% of its variation is a result of its own shock while oil price shocks (LNP), interest rate (INT) and inflation (INF) account for 15%, 8%, and 23%, respectively. The variance decomposition of interest rate (INT) indicates that 55% of its variation is a result of its own shock while oil price shocks (LNP), exchange rate (EXR), and inflation (INF) account for 5%, 8%, and 32%, respectively. The variance decomposition of inflation (INF) indicates that 51% of its variation is as a result of its own shock while oil price shocks (LNP), exchange rate (LNE) and interest rate (INT) account for 20%, 13%, and 15%, respectively.

Conclusions and Policy Recommendations

The objective of the paper is the empirical examination of the impact of oil price shocks on macroeconomic prices in Nigeria, using annual data for the period 1981 to 2015. The paper employed the vector autoregressive (VAR) model through the analysis of impulse response functions (IRFs) and variance decompositions (VDCs). The results from the impulse response functions revealed an inverse relationship between macroeconomic prices namely, exchange rate, interest rate and inflation and it is statistically significant except that of interest rate. From the variance decompositions, it found out that positive oil shocks contributes 15%, 5%, and 20% of the variations in exchange rate, interest rate, and inflation respectively over the 10years horizon. The implication of the result is that shocks from oil prices has the potentials of causing significant changes in exchange rate and inflation in Nigeria while interest rate is not significantly determined by oil price shocks in the country. It recommends that the Nigerian authorities should devise a means for absorbing shocks in the event of blows from oil prices with regards to exchange rate and inflation by diversifying to non-oil exports that could generate more foreign exchange to the country.

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