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DO OIL PRICES FORECAST THE INTERBANK MARKET INTEREST RATES IN NIGERIA?

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Abstract

We aim to establish the nexus between crude oil price and the interbank interest rate in order to ascertain if crude oil prices possesses a predictive ability on the interbank interest rates in Nigeria by using monthly series ranging from 2002:1 to 2021:12. The result of the Johenson Conitegration test indicated the existence of a long-run relationship between interest rate and crude oil prices, the variance decomposition and impulse response function results trace the behaviour of interbank interest rate as accounted by shocks on oil prices. The test of volatility using GARCH (1,1) confirmed that volatility was quite persistent while the Granger Causality test confirmed that oil price granger caused interbank interest rate. Finally, the forecast of interbank interest rate using structural autoregressive moving average (SARMA) revealed that oil price adequately forecast the behaviour of interbank interest rate. It is therefore recommended that policies in tackling the impact of fluctuations in oil prices should be formulated which will serve as an important source of stabilizing the movements in the interbank interest rate. Considering the importance of oil to the development and growth of the Nigerian economy, a focus to diversify the Nigerian economy away from over-dependence on oil revenue to other productive sectors of the economy using the financial receipts from crude oil will help to stabilize the interbank rates.

Keywords: *Interest Rates, Oil Prices, Inflation Rate.*

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NOTE: The views expressed in this article are those of the authors and are not necessarily the views of the institutions they are affiliated or work with.

1. Introduction

Economic activities of developing countries like Nigeria are altered by the interplays or movements in the international price of oil due to the country's peculiar characteristic which doubles as an oil exporting country and at the same time, an oil importing country. Oil exporting countries especially the developing once depend heavily on oil receipts for its foreign exchange earnings and for the government budgetary outlays. For instance, in Nigeria, receipts from oil have accounted for an average of 72.77 per cent of government revenue and foreign exchange earnings between 1981 and 2021 (CBN Statistical Bulletin 2021). On the other hand, the interbank interest rate is an overnight interest rate which covers the cost of funds borrowed within the banks in order to shore up the liquidity positions on daily basis. This daily borrowing activity dovetails to the determination of a bank's ability to avail funds for the business agents or have shortfall for the liquidity needs of their customers. The interbank interest rate represents the cost of borrowing funds amongst banks. These borrowings are meant to manage individual banks' liquidity conditions and this liquidity conditions generally reflect on the interest rate position at the interbank market.

Given its peculiarity of exporting a single product, the Nigerian economy remains highly vulnerable to the volatilities in crude oil prices and the receipts from oil sales influences the liquidity conditions in the banking system. Episodes of increasing oil prices mostly triggered by any form of crisis in oil-producing areas, can improve the aggregate demand, current account position and exchange rate stability of oil producing nations like Nigeria. On the other hand, if oil prices decline, motivated by fallen demand in oil and excessive supply, the domestic economy witnesses a sharp drop in foreign exchange flows that often result to a combination of fiscal and external accounts deficit leading ultimately to slower growth. Instances of low crude oil prices in the 1970s, 1980s and more recently, during global financial crisis of 2007 to 2009, as well as the 2014/2016 oil price fall, accompanied a slower output growth in Nigeria, depreciated exchange rate and systemic banking problems driven by volatility in the interest rates and inconsistency in government revenue.

Several studies have been conducted in Nigeria on the nexus that exist between stable exchange rate and oil price volatilities. Notable amongst these studies is Mohammed et al (2019) and Abubakar (2019). Their conclusions revealed a positive relationship between exchange rate and crude oil price in Nigeria. This implies that innovations that translates to rise in crude oil prices influences the exchange rate of the naira to a dollar to appreciate. Conversely, episodes of declining oil price results in exchange rate depreciation. The impact of this relationship between exchange rate and oil price reflects on the liquidity conditions in the Nigeria economy and permeates into the banking system through the monetization process of the monthly Fiscal Account Allocation Committee (FAAC) distribution – a process of fiscal allocation funds from the central government to the sub-national governments, leading to the determination of cost of funds at the interbank market. While there are numerous studies on the exchange rate and oil price nexus in Nigeria, there is dearth of empirical investigation on whether oil prices can predict the behaviour of interest rates in Nigeria. However, in Norway, a study by Karlsson et al (2018) revealed the existence of a causal relationships between oil price and interest rate at the longest time scale of eight quarters. Since oil price volatility directly affects the revenue level of the government which in turn impact on the banking system liquidity level through the allocation of funds to the subnational governments, a need to empirically ascertain if this development has a direct impact on the interbank interest rate in Nigeria.

In Nigeria, the monthly Federal Account Allocation Committee (FAAC) meetings and subsequent distribution of funds from the central to the sub-national governments causes fluctuations in the money market interest rates. An observation showed that the interbank rates move up just before the FAAC meeting due to withdrawals to fund the federation account from revenue generating agencies like the Nigerian National Petroleum Corporation (NNPC) and the Federal Inland revenue Services (FIRS) and sharply downward in response to the huge injections of liquidity into the accounts of the sub-national governments immediately after each meeting of the FAAC. An increase in international oil prices impacts positively in the Nigerian government revenue which in turn creates high liquidity level in the banking system (Isah et al (2014). Given the foregoing, the paper seeks to investigate if a relationship exists between oil price and the interbank market interest rates and test for a forecasting ability of this relationship if it exists. In doing this, interbank rates and oil price data from 2002:1 to 2021:12 was used to conduct various econometrics analysis.

Following this introduction, the remaining part of the paper is structured thus: the next section gives an insight into the existing literature on this subject starting with the theoretical framework, the existing empirical literature and the stylized fact. The third section looks at the methodology adopted for the study and explanation of the variables used for the analysis. Section four presents the model and proper discussions of the result, and the section five is the concludes and proffers some recommendations.

2. Literature Review

2.1 Theoretical Literature

A plethora of theories on interest rate determination exist in economic and finance literature. This is made up of theories that include both classical and modern theories which takes cognizance of real factors as well as the monetary factors to determine the cost of funds (i.e. obtaining interest rate through the IS-LM curve). Several assumptions are taking care of by these theories in order to ascertain the behaviour of economic agents. In the classical theory, the supply and demand savings theory and the market fundamentals of capital determines interest rate levels. This is to say that following the classical theory, the behaviour of demand curve – demand for capital for both productive and consumptive purpose, and the supply curve – the savings level, determines the rate of interest.

The theory of interest rate determination was proposed by the neo-classicist on basis that supply and demand of funds. In this regard, the rate of interest determination is based on the cost of credit which is reflected in their respective demand and supply curve. The theory identified three sources of demand for funds to include: business agents, governments and consumers, while supply of loanable funds is determined by bank credit, dishoarding and saving (Jhingan, 1997). This implies that any shock on the demand or supply sides of loanable funds results in changes of cost of funds (interest rates).

The liquidity preference theory propounded by Keynes stipulated that interest rate is determined by the behaviour of economic agents who prefer the availability of liquidity ahead of investments. Therefore, Keynes proposed that the determination of interest rate pertains to the price that equilibrates the need to hold cash as wealth with available quantity of cash. This is to say that the supply and demand of money determines the rate of interest. Within this arrangement, the supply is assumed to be fixed by the monetary authority, while demand relies on three motives namely – the transitionary, precautionary and speculative motives.

The rational expectation theory for the determination of rate of interest is on the basis that economic units take economic decisions by relying on fundamentals that projects rational outlook, current information as well as the immediate previous experience in the market. According to the theory of rational expectation, the best estimation for interest rate of the future remains the spot rate while the determinants of changes in interest rate include market information and other economic factor that economic agent rely on for decision making.

However, one main constraint of the theory is the challenge of obtaining market information and having a thorough understanding of how agents transform information to build expectation.

Recent approaches to interest rate determination which is based on the IS-LM methodology take cognizance of liquidity preference, productivity, money supply growth and thrift as some of the most important interest rate determinant. The LM curve is derived from the liquidity preference theory of the Keynesian approach to interest rate determination while the IS curve is formed from the loanable fund theory.

Beyond the mechanics of determining interest rate level, another vital area relates to how this rate of interest impact on the level of liquidity specifically in the banking system. Augustine et al (2018) identified that the indicators of banking system liquidity include the movements of interest rate, deposit money banks' closing balances, value and volume of transactions in the standing lending facility and standing deposit facility and the volume of activities in the money market. The study further identified that low bank balances is a signal to tight monetary condition in the banking system, while large positive fund balances on the accounts of the DMBs signifies a high liquid condition of the system.

Driving home the relationship between the liquidity growth and oil price, Musa and Zoramawa (2014) established that there exist a long run relationship between government revenue and the level of money supply growth in the Nigerian economy. As highlighted earlier, given that oil receipts accounts for an average of 72.77 percent of the government revenue and foreign exchange earnings (CBN Statistical Bulletin 2019), it would be right to assume that a reasonable portion of these revenues finds its way into the banking system liquidity levels. There some consensus in theoritical literature that establishes a direct relationship between oil price fluctuations or shocks and the expenditure pattern of the Nigerian government revenue and expenditure Ganiyu (2016), Adedokun (2018) and Gylych (2020). In a nutshell, increase in oil prices tends to affect the economy in two difference ways because of the dualistic impact of crude oil in the economy. The economy doubles as an oil exporting and at the same time, a petroleum refined importing economy. Additionally, proceeds from the sale of crude oil forms the significant part of both the central government and the sub-national fiscal needs. Isah et al (2015) confirmed the interest rate volatility arising from the monthly Federal Allocation Account Committee (FAAC) distribution cycle driven mainly by the receipts from crude oil sales.

Theoretically, the transmission mechanism between the change in oil prices and the economy stems from both sides of the market fundamental channels. According to Karlsson et al (2018), from the demand side channel, changes in oil price can impact on consumption and investment, entailing wealth transfer effect on the purchasing power of exporting and importing countries. For oil importing countries, increasing oil price can reduce consumer demand but increase the consumer demand of oil exporting nations. On the other hand, the supply side effect emanates from oil being an important production input. Rising oil price results in increased cost of production which directly leads to output reduction of firms.

Due to the peculiarity of the Nigerian economy, increase in oil prices tends to affect the economy in two difference ways because of the dualistic impact of crude oil in the economy. The economy doubles as an oil exporting and at the same time, a petroleum refined importing economy. Additionally, proceeds from the sale of crude oil forms the significant part of both the central government and the sub-national fiscal needs. Isah et al (2015) confirmed the interest rate volatility arising from the monthly Federal Allocation Account Committee (FAAC) distribution cycle driven mainly by the receipts from crude oil sales.

2.2 Empirical Literature

Even though a vast literature exist on the effects of oil prices on the financial market activities such as the foreign exchange, equities and bonds markets, there are relatively very few studies that have investigated empirically, the predictive nature of oil prices on the interest rates and precisely on the interbank market interest rates in developing countries.

In the US, Reicher (2010) researched on the relationship between oil prices and long-term interest rates by estimating a seven-variable vector autoregressive for the economy using a post-war long-run restricted data. The study took cognizance of changes in interest rates (long-run) and inflation expectation and found that a strong connection exist between interest rate and oil prices and this relationship has lasted throughout the post-war era. Other authors in the U.S have also delved into unravelling the oil price and interest rate nexus. Killian and Zhou (2018) relied on the structural vector autoregressive (VAR) model to establish that a sustained surge in real price of crude oil is often associated with the declining real value of U.S dollar and low U.S real interest rates, coupled with improved global economic activity. The study proposed a new identification strategy for the causal effects of oil demand and supply shocks the effects the have on the U.S interest rates and the real value of the U.S dollar.

In measuring the effect of oil prices on the behaviour of inflation rate, interest rate and money in Taiwan, Wu and Ni (2011) adopted a vector autoregressive model to ascertain if oil price will have a lag or contemporaneous effects on interest rates, onflation rates and money. Firstly, the granger causality test showed that oil prices and inflation rate has a two-way causality confirmed by both the symmetric and asymmetric models. In addition, the study confirmed a unidirectional effect of oil prices on interest rates and a feedback effect was observed between oil prices, inflation and money.

In another study by Wang and Chueh (2013), the dynamic transmission effect between interest rate, exchange rate of the U.S. dollar, crude oil and gold prices was examined. By applying the threshold co-integration technique, the authors observed that interest rate influences the U.S. dollar rate, which turn around to affect the international price of crude oil. The study further observed that when the Federal Reserve reduces interest rate, to encourage economic activities, market expectation for crude oil demand immediately changes, and as a result of that action, crude oil prices begin to fluctuate. Also, a price transmission between interest rate and gold prices were observed. Another important observation was that a reduction in interest rates necessitate investors expectations through the depreciation of the exchange rate, warranting portfolio shift to precious commodities like gold. Finally, the study established that gold and crude oil prices have a feedback effects on interest rates, therefore, the authors inferred that increases in oil prices to a certain threshold would trigger inflation and at this point the Fed would tighten monetary policy rate in order to moderate the economy.

In Nigeria for instance, Maijama'a and Musa (2020) applied the Toda and Yamamoto long-run causality procedure to measure the nexus existing amongst crude oil prices, interest rates and unemployment in Nigeria. The study identified that a one-way causality transmitting from crude oil to unemployment exist, population growth and unemployment, unemployment to interest rate and crude oil to interest rate. However, the study did not make any recommendation on their establishment of the nexus between oil prices and interest rates in Nigeria. Their recommendations focused more on advising the Nigerian government to develop other non-oil industrial sectors in order to create employment opportunities and export promotion in Nigeria.

In the literature, most common studies are those that related oil price developments and a variety of economic indicators such as the relationship between oil prices and exchange, economic growth, inflation. Some of these studies are further examined and presented. For instance, Aliyu (2009) conducted a study to ascertain the effect of oil price shock on the exchange rate volatility vis-à-vis the economic growth. The study analyzed the oil price and exchange rate time series properties and examined the causality amongst the variables. Furthermore, cointegration technique using Johenson VAR based model was used in examining the long-run effect of economic growth sensitivity to variations in real exchange rate and oil prices. An analysis on the short-run dynamics was conducted using the vector error correction model and the granger pairwise causality test indicated a bidirectional causality from real exchange rate to real GDP and vice versa, whilst for oil prices and the real GDP growth, a unidirectional causality was established. Also revealed in the study was that positive oil price shocks and exchange rate appreciation transmits positively to real economy in Nigeria.

In another study conducted by Mordi and Adebiyi (2010) which asymmetrically evaluates the effects of oil price shocks on price and output in Nigeria, applying a monthly time series from 1990 to 2008 using the structural VAR model, the result identified an asymmetric response of oil price shocks on output and prices: with the impact being more significant on oil price declines than oil price increases. The result of the variance decomposition showed that variations in oil prices contributes to determining output and prices in Nigeria. The authors implied that to move the economy forward, policies should be aimed at achieving price stability in which oil prices play a significant role.

Omolola (2006) used a quarterly time series from 1970 to 2003 to measure the impact of oil price shock on some selected macroeconomic fundamentals such as output growth, real exchange rate inflation and money supply in Nigeria. Having adopted the vector autoregression model for this assessment, the study revealed that shocks emanating from oil prices have no direct significant effect on output and inflation in Nigeria, but real exchange rate was significantly affected by oil price shocks. The authors further highlighted that shocks from oil prices might introduce wealth effect which in turn improves the real exchange rate and tightens the tradable sector of the economy – this will lead to Dutch Disease. A similar study by Akpan (2009) evaluated the link between output and oil price shocks in Nigeria using the VAR and his findings indicated that both positive and negative shocks in oil prices affect inflation negatively and boost real output through export earnings expansion, even though the benefit is offset by slower demand of export arising from economic downturn of trading partners. In addition, the study showed a strong positive relationship between changes in oil prices and government real expenditure.

To investigate the systematic monetary policy and effects of shocks in oil prices, Bernanke, Gentler and Watson (1997) suggested that following an oil price shock that hit the US economy, if the Federal Reserves (FED) had not increased interest rates, the downturn recorded in the economy might have been largely avoided. Their work clearly showed that US economy reacts differently to oil price shocks in situations where the FED fund rate is limited to be constant compared to the situation where monetary policy is unhindered. A positive shock in the oil price will lead to an increase in the fund rates and decline in real GDP under the unconstrained regime. Holding the federal fund rate constant, the authors observed that the real GDP and inflation rate will increase given a positive oil price shock. Given the foregoing, the result indicated that the main importance of real effect of shocks in oil price arising from monetary policy response. On the contrary, this conclusion was challenged by Hamilton and Herrera (2001) based on two unique grounds. First, it was discovered that both the magnitude and nature of the actions suggested for the Fed are adequately inconsistent with correlations to question the viability of such a policy.

In a similar construction of the US economy, Brown and Yucel (1999) adopted the VAR model replicate the works of Bernanke, Gentler and Watson and established that as subsequent to an oil price shock, the U.S economy responds with an increase in the interest rate and price levels while the real GDP reduces. Given that the fall in real GDP and the increase in the deflator are comparable in magnitude, so that the nominal gross domestic product continues to remain constant.

In measuring the robustness of the oil price vis-à-vis macroeconomics relationship, Hooker (1996) studied the effect of oil price shocks on the gross national product by evaluating the response of interest rate on changes in oil prices. The result indicated that monetary policy responds to oil price increase and decrease and this was confirmed by the result of the impulse response function which ascertained the asymmetric response of short-term interest rate on oil price fluctuations, meaning that shocks in oil price affect the GDP through the interest rate channel though asymmetrically.

In a study by Doğrul and Soytas (2010), the authors investigated the nexus between oil prices, interest rates and unemployment in Turkey, relying on the efficiency wage model of Varruth et al (1998). A good number of literatures agrees that oil price shocks adversely affects the economies of developed countries. By adopting the Toda-Yamamoto procedure, their study supports the evidence that prices, including price of oil, impacts negatively in the unemployment of Turkey. Their result also showed that both the real oil price and interest rate affect unemployment rate adversely in the long run. This further confirms the work of Carruth, et al (1998) results for the U.S. economy.

Alessandro Cologni and Matteo Manera (2005) used the structural vector autoregressive (SVAR) model to consider effect of oil price shock on prices, economic activities and the response of monetary developments and its variables to external shocks amongst the G-7 countries. In most of the countries studied, the analysis showed that there exist an impact of unexpected shock of oil price on the rate of interest, implying a tight monetary policy response geared to curb inflation. On the other hand, rise in interest rates are transmit to the real economy by declining output growth and inflation rate.

Using a wavelet multi-resolution analysis (MRA) method, Karlsson et al (2018) combined causality test in two different ways, to ascertain the impact of three variables on each other: unemployment, real oil price and real interest rates in Norway. The effect of innovation amongst the variables were analyzed through the impulse response functions. The result showed that a causal relationship seemed to be stronger amongst the variables when the wavelet time scale rises; to be specific, at the smallest time scale of three months, no causal relationship existed between the variables, however, unemployment and interest rates exhibited a casual relationship from the first two quarters to two year period. And at this time, unemployment and interest rates were identified to possess a feedback mechanism.

In conclusion, it can be observed that of all the literature reviewed, none of them were studies conducted in an oil dominant economy with peculiar characteristics of the Nigerian economy. The special feature of the Nigerian economy is that it doubles as an oil exporting and import economy. Shock and volatilities emanating from oil prices affect the economy both negatively and positively depending on direction of price variation as discussed earlier. Therefore, it is important to examine the forecasting ability of oil prices on interbank interest rates in Nigeria. Based on the available literature reviewed, there is no study of this kind conducted for the Nigerian economy and this study aims to fill this gap and contribute its finding to the body of knowledge in this area.

3. Data and Methodology

3.1 Data

This section analyses the relationship between oil prices and interbank market interest rates by evaluating whether oil prices have extrapolative forecast for interbank market interest rates in Nigeria. Monthly time series data of bonny light oil price (OP) and interbank interest rate (INT) over the 2002:1 – 2021:12 obtained from the Central Bank of Nigeria (CBN) and Bloomberg terminal were used in setting up the model.

3.2 Model Specification

This study therefore adopts the multivariate cointegration vector autoregressive (VAR) model advanced by Johansen (1988) and Johansen & Juselius (1990 and 1992). The method is preferred over above other methods given a lot of reasons. Firstly, no a priori assumptions of exogeneity of variables are needed. Secondly, VAR model permits every variable in the model not only to impact on itself but to also on each other without been imposed by a theoretical structure on the estimates. Finally, the method offers an opportunity of not just ascertaining how a given variable impacts itself but on the other variables of concern through the impulse response function and the variance decomposition (Akinlo 2012). The model as specified by Johansen and Juselius (1992) is as stated below in equation (1)

$$\Delta X_t = \mathrm{C} + \sum_{i=1}^{p} \pi i + \Delta x_{t-1} + \pi x_{t-1} + \Psi_{zt} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

where π's (i = 1,…, ρ) represents the (2x2) variable matrices;

Δx_{t-1}, ΔX_t represents the (2x1) first difference X_t for column vector;

π is a (2x2) of the variables x_{t-1} which is a (2x1) for the column vector of the lagged endogenous variables;

zt indicates a (2xn) matrix comprising n explanatory variables for each endogenous variable; and

εt represents a (2x1) column vector of the error term normally distributed with constant variance and zero mean.

3.3 Estimation Procedure

Overall, the features of the time series determine if the vector-error corrections or unrestricted Vector Autoregressive (VAR) would be applied for the purpose of estimation. In the case of cointegrated non-stationary variables, the right specification is VECM. Consequently, both the stationary and cointegration test are carried out on the variables. Two main tests were employed to test for stationarity, namely; the Philips-Perron (PP) and Augmented Dickey-Fuller (ADF).

In order to estimate the forecast ability of oil prices on interbank interest rate, a test to indicate if oil prices possess a significant predictive quality was conducted and the out of sample forecasts in the monthly variable was used for the test. Estimation of the coefficient in the model with rolling in-sample forecast and produce a sequence of two-step-ahead pseudo out-of-sample forecasts conditional on the realized value of price of oil. This autoregressive moving average (ARMA) model, using the Box – Jenkins approach was adopted. Putting together the AR(p) and MA(q) properties, an ARMA(p,q) model is obtained. The ARMA model states that the present value of some of the series y depends linearly on its own previously values in addition to the combination of current and previous values of a white noise error term. The model could be written as:

$$\varphi(L)y_t = \mu + \theta(L)\mu_t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

Where

$$\varphi(L) = 1 - \varphi_1 L - \varphi_2 L^2 \ldots\ldots\ldots \varphi_p L^p \text{ and} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (3)$$

$$\theta(L) = 1 + \theta_1 L + \theta_2 L^2 \ldots\ldots\ldots \theta_q L^q) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (4)$$

Or

$$y_t = \mu + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \cdots + \varphi_p y_{t-p} + \theta_1 \mu_{t-1} + \theta_2 \mu_{t-2} + \cdots + \theta_q \mu_{t-q} + \mu_t \quad \ldots.. \ (5)$$

With

$E(\mu_t) = 0$; $E(\mu^2_t) = \sigma^2$; $E(\mu_t\mu_s) = 0$, $t \neq s$

Where L is the lag operator, denoting the periods that y_t and μ are lagged; μ is the residual term. In order to incorporate the forecasting power of oil price vis-à-vis interbank interest rate, equation (5) is re-written to include oil price variable.

$$y_t = \mu + \Phi\lambda + \Phi\alpha + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \cdots + \varphi_p y_{t-p} + \theta_1 \mu_{t-1} + \theta_2 \mu_{t-2} + \cdots + \theta_q \mu_{t-q} + \mu_t \quad \text{..... (6)}$$

Where 'λ' = oil price while α is inflation rate included as a control variable in the model.

This makes the model to become a structural autoregressive moving average (SARMA). In line with Ghosh (2011) and Narayan et al (2008) approach, the relationship between rate of interest (interbank) and oil price and inflation rate is characterized using the ARCH (p,q) & GARCH (p,q) models.

Thus, the mean equation is stated as:

$$IBR_t = C + \beta OILP_t + \beta Infl + vt$$

…………... (7)

Given that vt represents the white noise residuals N (0, σ^2_t). For the second moment, GARCH(p.q) variance equation is of the form:

$$\sigma_t^2 = \theta + \sum_{i=1}^{p} \phi i v^2_{t-1} + \sum_{i=1}^{q} \varphi i \, \sigma^2_{t-j}$$

……………………..…………………….... (8)

Given the condition $\theta > 0, \varphi_i \, i < 1 \; and \; (1 - \phi i - \varphi_i) > 1$ stands for a GARCH (1,1) model.

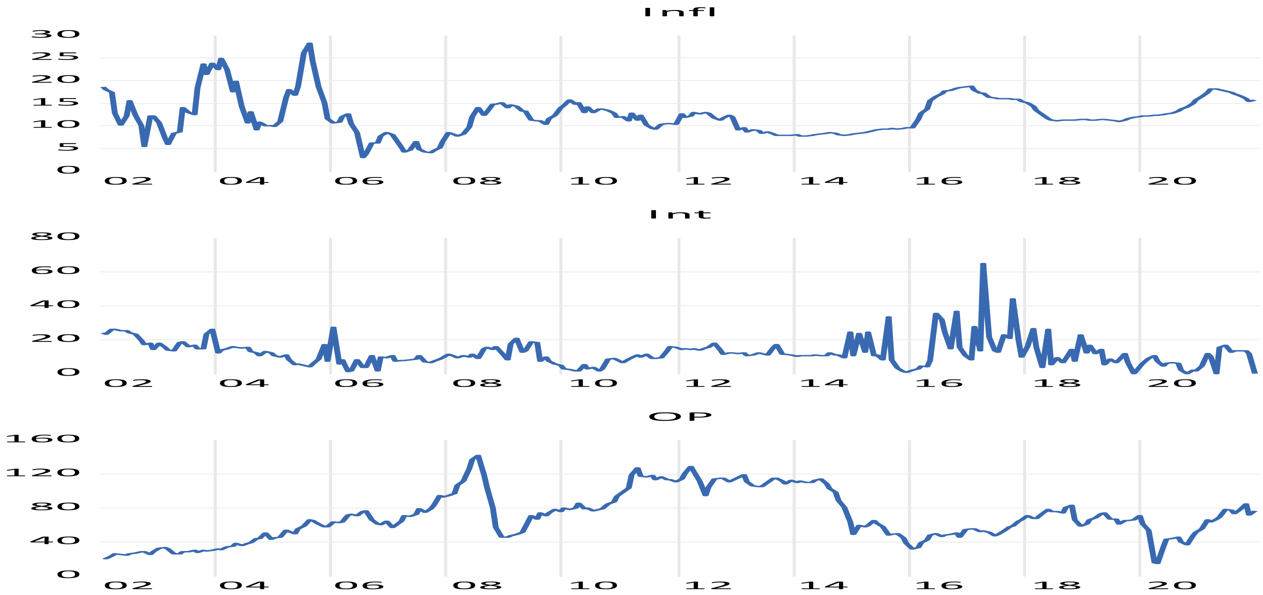
Eqn (8) explains the conditional variance as a linear function of p lagged disturbance and conditional variance. Having said this, volatility in the current period rely on the volatilities of the past period q and the previous period p for the squared residual. Often, GARCH models containing small values of p and q presents a valid estimate of volatility with p=q=1 scenario, often times been suitable for Narayan et al (2008) and Ghosh (2011).

4. Results and Discussion

4.1 Preliminary Analysis

As it is customary in most time series econometric analysis, the first step is to analyze the statistical properties and characteristics of the data especially as it relates to trend, direction of trend, existence of structural breaks and stationarity. The natural log form of the variables used in model are presented in Figure 3 below. The figure shows that both the oil price and interbank interest rate did not exhibit any deterministic trend and obvious structural breaks were identified in the graphical presentation.

Figure 3: Graphical Presentation of Variables



Source: Central Bank of Nigeria Database and Bloomberg

4.1.2 Description Statistics

The descriptive statistics shows that oil price, interbank interest rate and inflation rate have a mean value of US$68.93 per barrel, 11.99 per cent and 12.32 percent, while the median of the descriptive statistics shows that US$65.61 per barrel, 10.72 per cent and 11.98 percent. The variable with the highest maximum value for oil price stood at 141.26, the interbank interest rate is 64.58 and inflation rate is 28.21. The probability values for all the variables indicate that the variable are not normal and this is further indicated by the positive skewness of the variables which means that the distribution has a long right tail.

Table 1: Descriptive Statistics

	INFL	INT	OP
Mean	*12.32294*	*11.99958*	*68.93283*
Median	*11.98133*	*10.72000*	*65.61500*
Maximum	*28.21016*	*64.58000*	*141.2600*
Minimum	*3.002551*	*0.000000*	*13.88000*
Std. Dev.	*4.230032*	*7.831596*	*28.84179*
Skewness	*0.677185*	*2.014891*	*0.355039*
Kurtosis	*3.982963*	*11.87337*	*2.268111*
Jarque-Bera	*28.00534*	*949.7579*	*10.39872*
Probability	*0.000001*	*0.000000*	*0.005520*
Sum	*2957.506*	*2879.900*	*16543.88*
Sum Sq. Dev.	*4276.468*	*14658.80*	*198811.9*
Observations	*240*	*240*	*240*

Source: Author's Computation

Examining the time series properties of the variables in order to ascertain their stationarity using the Augmented Dickey – Fuller (ADF) and Philips – Perron (PP) unit root tests is an important step in the analysis. As presented in Table 2, interbank interest rate was stationary at level using both ADF and PP tests. However, oil price was stationary at first difference in both Augmented Dickey Fuller (ADF) and Phillip Perrron (PP) tests.

Table 2: Unit Root Test

ADF

At level				At first difference		
Variables	***Statistic***	***P-value***		***Statistic***	***P-value***	***Decision***
INFL	*-3.8732*	*0.0146***		*-13.3979*	*0.0000*	*I(0)*
INT	*-6.0412*	*0.0000****		*-11.2433*	*0.0000*	*I(0)*
LOP	*-2.6719*	*0.2493*		*-12.3997*	*0.0000****	*I(1)*
			PP			
INFL	*-3.7406*	*0.0215***		*-13.3356*	*0.0000*	*I(0)*
INT	*-10.7431*	*0.0000****		*-56.4328*	*0.0001*	*I(0)*
LOP	*-2.7671*	*0.2111*		*-12.7728*	*0.0000****	*I(1)*

*Note: ** and *** indicates 5% and 1% level of significance*

Cointegration Analysis

Having established the order of integration of the series, the next undertaking is to ascertain how many cointegrating factors exist with the variables. To do this, the Johansen (1998) was employed to set up the variable that is not stationary as a vector autoregressive (VAR) of order p. The summary of the cointegration analysis is presented in table 3 and it's measured with the Johansen maximum likelihood ratio test relying on the trace of stochastic matrix and maximal Engen-value. Variables for the cointegration test are oil price and interbank interest rate and the Max-Eigen and Trace test showed two cointegrating equations. The Trace statistics, MacKinnon-HaugMichelis (1999) *p-values* indicates a null hypothesis of no cointegration was rejected in favour of the alternative hypothesis at 0.05 level. Their values as shown in Table 3 are above the critical value at 0.05 level of significance, indicating the existence of a long run relationship among the variables.

4.2 Presentation of Results

Table 3: Cointegration Analysis

Trace test (λtrace)				Maximum eigenvalue test (λmax)			
H0	**H1**	**Statistics**	**95% Critical Value**	**H0**	**H1**	**Statistics**	**95% Critical Value**
r = 0	r =1	55.58	29.79	r = 0	r = 1	31.66	21.13
r ≤ 1	r =2	23.92	15.49	r ≤ 1	r = 2	16.26	14.26
r ≤ 2	r =3	7.69	3.84	r ≤ 2	r = 3	7.66	3.84

Source: Author's Computation

The normalized co-integrating coefficients are presented in Table 3 using the Johansen maximum likelihood ratio test which is based on the trace and Maximum eigenvalue tests. The result revealed the variables possess a long run relationship as shown in the 0.05 level of significance in both the trace test and Maximum-engenvalue test with three cointegrating equations. The result of the cointegration test also implies that as oil price increase, interbank interest rate would decline. This could be attributed to a decline in consumer price index arising from stable exchange rate of the Naira to a US$ as well as the increased liquidity condition which drives the interbank market interest rate down, following the monetization of oil proceeds and subsequent distribution of funds to the three arms of government.

Table 4: Normalized Co-integration Result

1 Cointegrating Equation(s): Log likelihood -2017.257

Normalized cointegrating coefficients (standard error in parenthesis)							
IBR	OIP	INFL					
1.000000	0.012740	-0.48623					
	(0.03950)	(0.27840)					

Source: Author's Computation

Having ascertained cointegrating relationship between the variables, the study therefore assesses on the short-run basis, the impact of the exogenous variables on interbank interest rate movement. The cointegration result indicates a set of cointegration series possess a representation of error correction, manifesting the adjustment mechanism of the short run. This is to ascertain if the short run changes are inclined the conditions of the long-run equilibrium, in order words, as shown in the cointegrating vector in table 5, the result of the vector error correction model and an assessment of the VEC term (Coint eq1) in Table 6 for the 1st vector indicated that the interbank interest rate possess a t-value of -0.417007 with an appropriate sign and statistically significant at 5.0 per cent significant level. This implies that 44.70 per cent of the disequilibrium in the interbank interest rate is corrected each month.

Table 5: VECM Estimate

Error Correction:	D(IBR)	D(OIP)	D(INFL)
CointEq1	-0.417007	-0.014282	0.005121
	(0.07367)	(0.07029)	(0.01896)
	[-5.66023]	[-0.20319]	[0.27010]

Source: Author's computation

Lag Length Selection Criteria

In determining the optimum lag length, a test for statistics including Final Prediction Error (FPE), Schwarz Criterion (SC), Sequential Modified Likelihood Ratio (LR), Akaike Information criterion (AIC) and Hannan Quin Information criterion (HQ) were conducted and they present diverse results. The LR indicates a lag length of four while the remaining criteria indicated a lag length of two. Therefore, lag length of two which turned out the highest number of lag lengths is selected. The result of the lag length was selection criteria is presented in Table 6.

Table 6: VAR Lag length Selection Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2549.203	NA	720801.6	22.00175	22.04632	22.01972
1	-1986.902	1105.212	6113.749	17.23192	17.41020	17.30381
2	-1960.774	50.68008	5274.723*	17.08426*	17.39625*	17.21008*
3	-1959.691	2.073225	5647.873	17.15251	17.59820	17.33225
4	-1953.630	11.44228	5793.923	17.17784	17.75725	17.41151
5	-1951.121	4.672434	6129.232	17.23380	17.94692	17.52139
6	-1937.618	24.79359*	5898.505	17.19498	18.04181	17.53650
7	-1934.703	5.276534	6220.004	17.24744	18.22798	17.64288
8	-1930.280	7.893178	6475.533	17.28690	18.40114	17.73626

Stability Test: AR Root Test

Ensuring the reliability of the coefficients of the normalized co-integrating model for the long-run and VEC model for short-run, the autoregressive (AR) root test was conducted for stability. The stability The VAR estimation is stable if the root features have modulus <1 and lies within the circle unit. Stability test conducted using the AR root as shown in Table 7 meets the stability conditions for the model. In order words, the model is good for the analysis given its stability.

Figure 4: Inverse Roots of Characteristics Polynomial

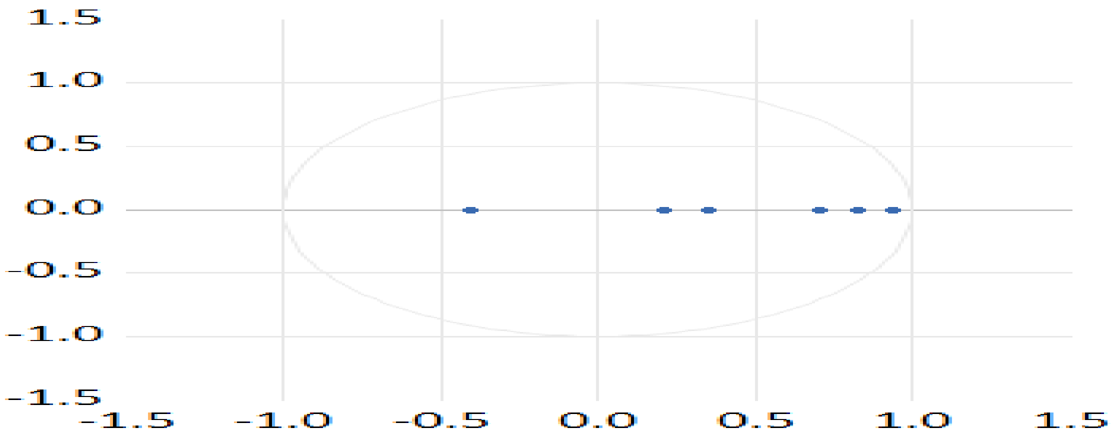


Table 7: Result of Stability Test

Root	Modulus
0.944412	0.944412
0.832736	0.832736
0.708629	0.708629
-0.400423	0.400423
0.349429	0.349429
0.215081	0.215081

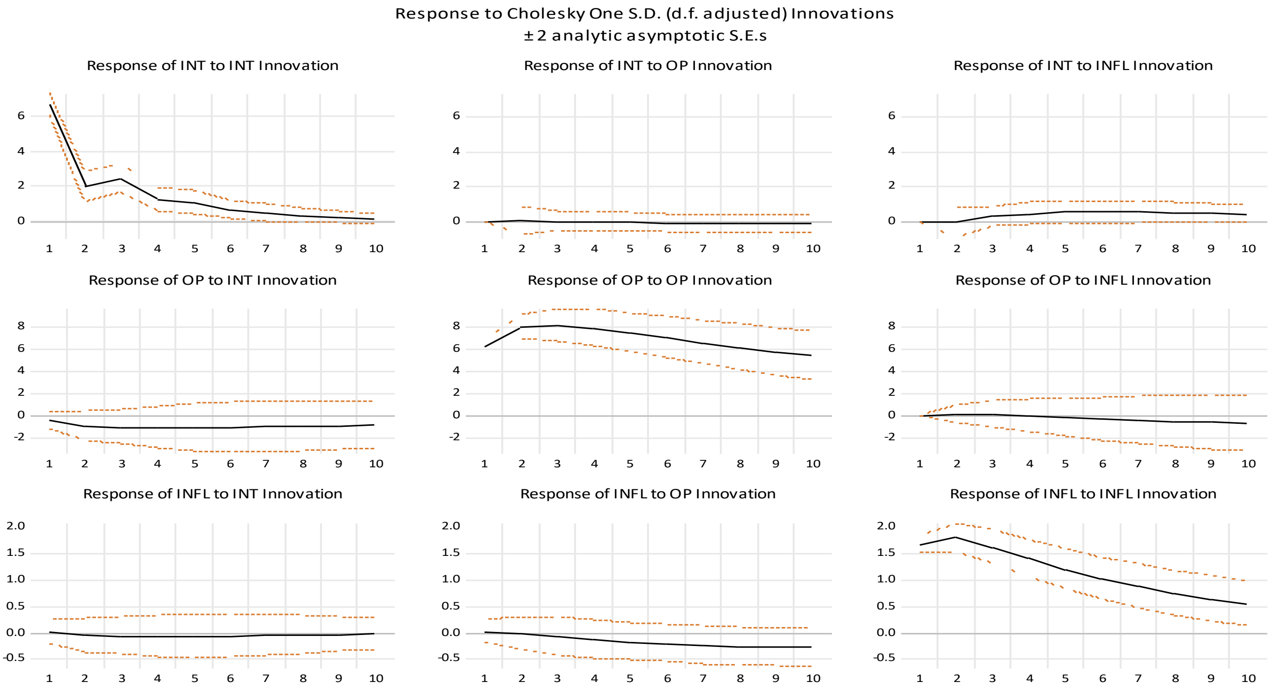
No root lies outside the unit circle.

VAR satisfies the stability condition.

4.3 Impulse Response Function

The result of the impulse response functions is presented in figure 5 and it traces the long-run response of the system variables to one standard deviation shock to the system of innovations ranging through ten (10) months period. It further indicates that the interbank interest rate (INT) responded positively to innovations on oil price (OP) throughout the forecast periods. INT further responded steadily to innovations on OP at an increasing rate in the 3rd month and it was able to sustain it till the end of the forecast horizon.

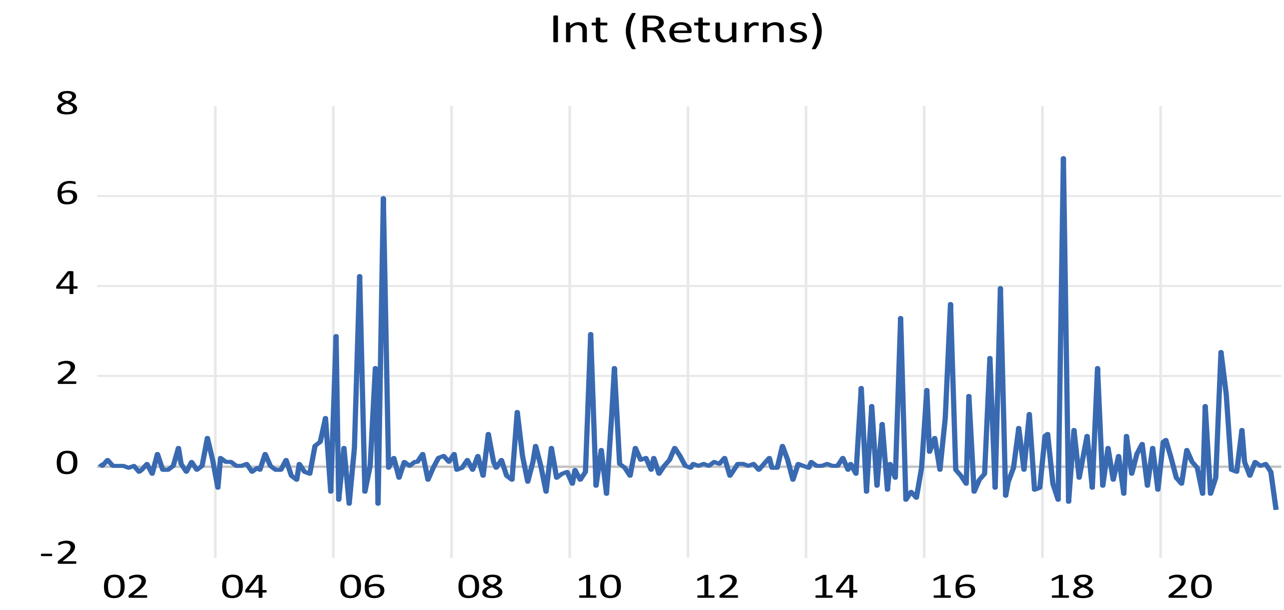
Figure 5: Presentation of the impulse response function

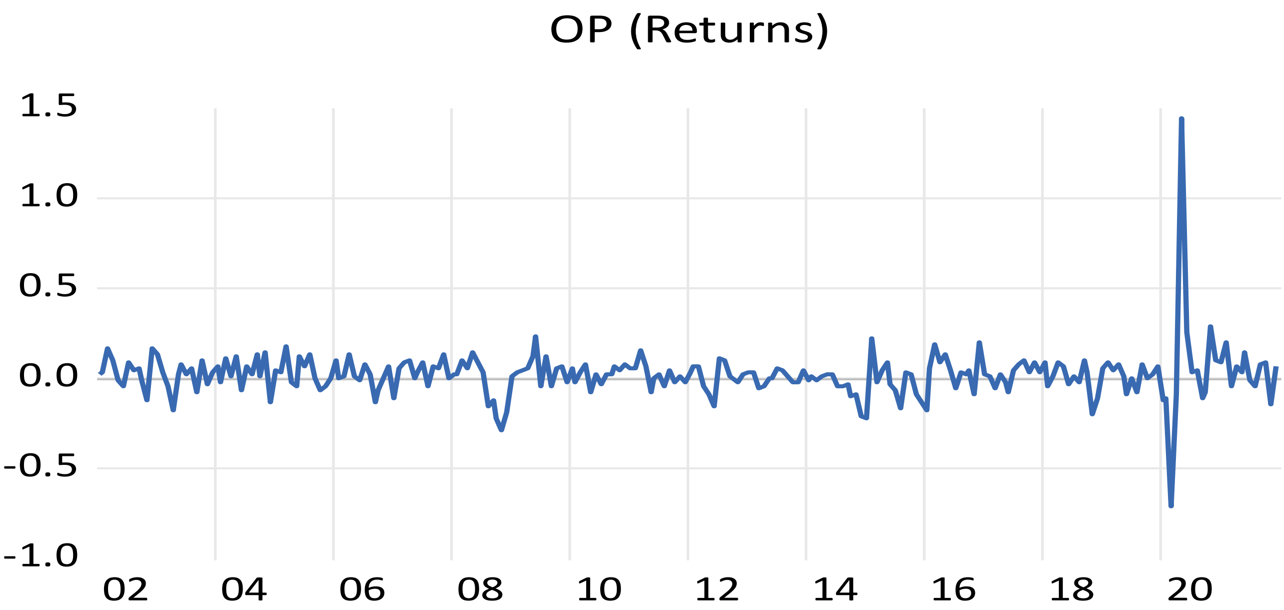


4.2 Test of Volatility

The volatility in oil prices and interbank interest rate from 2002:1 to 2021:12 in Nigeria is presented in Figure 6. As indicated in the VAR model, the a priori expectation suggest that an increase in the volatility of oil price should lead to more volatility in interest rate. The implication of the increases in oil price in 2008/2009 and 2014/2016 represents the sharp increase in oil price in June 2006 and the economic recession of 2105/2016 was replicated in the drastic increase in interbank interest rate during the period. A similar trajectory was also observed in 2020 as a result of the COVID-19 pandemic which impacted adversely on the international price of oil and the domestic banking system with obvious impact on the systems ability to create credits. Movements in the two charts exhibits a priori expectations.

Figure 6: Volatility in Oil Price and Interbank Interest Rate





*OP = Oil Price *INT = Interbank Interest Rate

The two models made efforts to solve the problem of ARCH effect in the residual series. The estimation of the GARCH (1,1) was conducted using the standard maximum likelihood method, taking cognizance of the normality assumption in the error distribution. As observed in table 8, the generalized conditional heteroskedasticity (GARCH) recommends that the shocks emanating from the volatility between oil prices and the interbank interest rate are persistent due to the corresponding coefficient of GARCH(1,1) of (0.21). Also, the mean equation obtained in the GARCH (1,1), an increase in the price of oil translates positively on the interbank interest rate. This is to say that a positive shock emanating from oil prices (in the case of Nigeria, we mean an increase in the price of oil) will translates to a 2.12 per cent fall in interest rate.

Table 8: GARCH (1, 1) Estimate

Variable	Coefficient	Std. Error	z-Statistic	Prob.
OP	-0.211997	0.062328	-3.401315	0.0007
Variance Equation				
C	0.004396	0.002455	1.790873	0.0733
RESID(-1)^2	4.460041	0.376185	11.85598	0.0000
GARCH(-1)	0.222558	0.027723	8.027806	0.0000

The Pair-wise Granger-Causality test was also carried out to test for causal relationship between oil price and interbank interest rate. From the result presented in Table 9, a uni-directional relationship existed between OP and INT based on standard F-test. It can therefore be concluded innovations in the past value of oil price could explain changes in the present value of interbank rates.

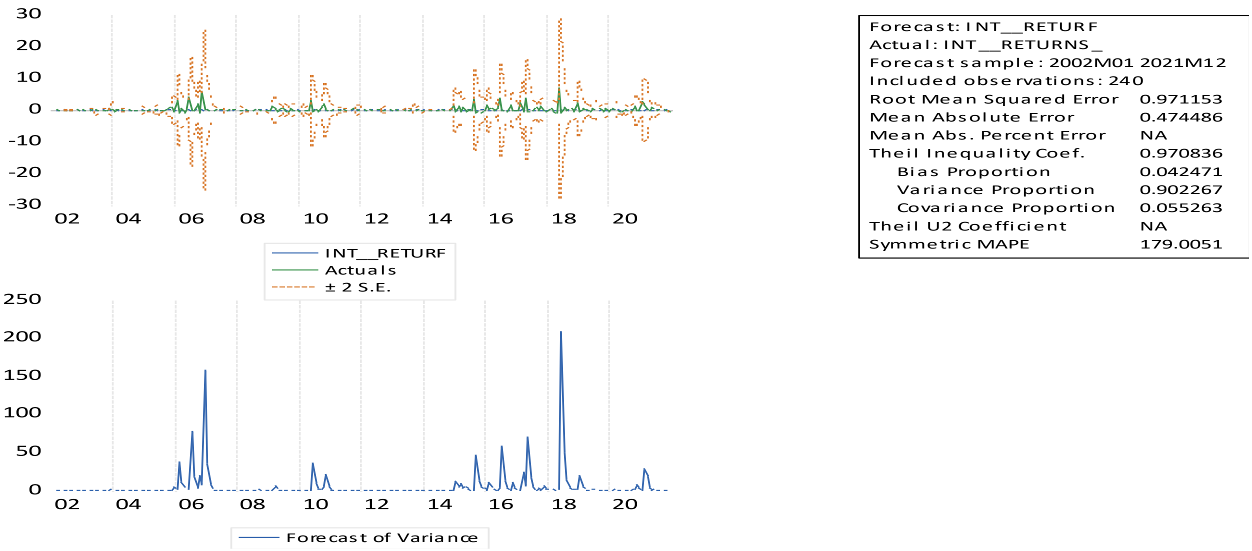
Table 9: Pair-Wise Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
OP__RETURNS_ does not Granger Cause INT__RETURNS	239	0.08517	0.9184
INT__RETURNS_ does not Granger Cause OP__RETURNS		0.76691	0.18039

4.4 Forecast of Real Interbank Interest Rate

The structural Autoregressive Moving Average (SARMA) model using the Box-Jenkins methodology was used to forecast the future values of INT as indicated by OP. We conducted an out-sample forecast for the dependent variable (Interbank Interest Rate (INT)) and both the forecast and actual values are presented in Figure 8. As seen in figure below, the model can track the past values of the dependent variables with high level of accuracy.

Figure 8: Actual and Predicted Values of the model



5. Conclusion and Recommendations

This study sought to unravel the relationship between interbank interest rate and oil prices in Nigeria by applying monthly series of the variables covering from 2002:1 to 2021:12 in order to ascertain whether oil prices could forecast movements in developments in the internal interest rate in Nigeria. The VECM result indicated that interbank rate possesses an adjustment mechanism which responds to variations from equilibrium in a balancing manner. The GARCH test result also advocates the persistence of volatility between interbank interest rate and oil prices. Finally, a one year-ahead forecast of interbank rate was made and the result closely reflects the actual interbank rate.

Thus, we conclude that oil price is an important determinant of interbank interest rates in Nigeria. It is therefore recommended that government should formulate policies in tackling the impact of fluctuations in oil prices which will serve as an important source of stabilizing the movements in the interbank interest rate. Also, considering the economic importance of oil to the Nigerian economy, therefore, diversification through capital investments in more productive sectors of the economy using the financial resources obtained from crude oil will help to stabilize the interbank interest rates.

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