Impact of Oil Price Volatility on Exchange Rate in Nigeria

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Abstract: **- Crude oil price plays an important role in influencing the economies of crude oil exporting countries like Nigeria. This impact can either be negative or positive depending on whether the price of crude oil in the international market increases or decreases. Nigeria moved from managed float exchange rate regime in 1986 shortly after the adoption of Structural Adjustment Programme (in 1986) to a free float exchange rate regime. However, time series data have shown that oil price and exchange rate are correlated because a sudden change in the price of crude oil in the international market is always accompanied by a period of fluctuations in the exchange rate value of the currencies of oil exporting countries, especially when the economy is oil-export dependent. This study therefore is aimed at examining impact of oil price volatility on exchange rate in Nigeria. In doing this, annual time series data from 1986 to 2015 were utilized. The Autoregressive Distributed Lag (ARDL) Bounds testing procedures was used for this study because the variables were integrated of order I(0) and I(1) and granger causality test were used to estimate the exchange rate and causality models respectively. The exchange rate model showed a good fit, 99 percent of the variations in the dependent variable were explained by the independent variables and hypotheses tested at 1, 5 and 10 percent levels of significance. The results indicated a negative but significant relationship between volatility of crude oil prices and exchange rates in Nigeria in the long-run. In the short-run, however, this relationship was negative and statistically not significant within the period of study. The results also showed money supply (M2), gross domestic product (GDP) and lending interest rate as important determinants of exchange rate in Nigeria in the short and long runs. The granger causality result indicated there is no causality between oil price volatility and exchange rate. The study recommended urgent shift in the Nigerian economy from crude oil export to none-oil exports through the exploration of other solid minerals and even agricultural produce. It also recommended swift effort to increasing Nigeria's foreign exchange reserve in the short run so that it can serve as a shock absorber against crude oil price volatility that negatively affect the Naira exchange rate in the long run.**

I. INTRODUCTION

One of the objectives of establishing central bank is to maintain external reserves to safeguard the international value of the legal tender currency. However, this objective is increasingly becoming difficult to achieve in recent times by the frequent changes in macroeconomic variables including exchange rate values of currencies of crude oil exporting economies sometimes occasioned by fluctuations in crude oil price. With the presumed influence of crude oil price fluctuations on domestic currencies of exporting countries, researchers within and outside Nigeria has shifted attention on the relationship between crude oil price on exchange rate. Prior to 1986, the Nigerian government adopted fixed exchange rate policy, wherein value of the naira was pegged against the British pounds sterling and soon after changed to U.S Dollar from 1970 to 1985, exchange rate of the naira was below one naira to a dollar while annual average crude oil price fluctuates. Crude oil prices and exchange rates data available prior to 1986 has shown that exchange rate was relatively stable compare to crude oil price.

In 1970, the average annual crude oil price was1.21 dollars per barrel while the average annual official exchange rate of the naira relative to a dollar was 0.714 kobo. From 1971 to 1973, international crude oil price increased slowly to 1.7 dollars per barrel in 1971, 1.82 dollars in 1972 and 2.7 dollars in 1973. However, the naira value appreciates from 0.714 kobo in 1970 to 0.713 kobo, 0.658 kobo and remained at 0.658 in 1971, 1972 and 1973 respectively. In 1974, the average annual crude oil price rose to 11 dollars per barrel while the naira exchange rate value appreciates to 0.630 kobo. Similarly, price of crude oil fell to 10 dollars per barrel in 1975 and increased to 11.6 dollars per barrel in 1976 while naira value further appreciate to 0.616 kobo in 1975 and depreciate slightly to 0.627 kobo in 1976.

From 1977, oil price increased continuously from 12.5 dollars per barrel to 35.52 dollars in 1980 and eventually fell to 29.04 dollars, 28.2 dollars and 27.01 dollars between 1983 and 1985 while naira exchange rate depreciate to 0.645 kb in 1977, appreciate to 0.547 kobo in 1980 and kept depreciating from 0.618 kobo in 1981 to 0.673 kobo, 0.724 kobo, 0.767 and 0.894 kobo for 1982, 1983, 1984 and 1985 respectively. It is seen that despite swings in annual price of crude oil, naira/dollar exchange rate was all through below one naira to a dollar. Thus, oil price fluctuations could not account for exchange rate movement in Nigeria during these periods because the value was fixed.

In 1986, the Nigerian government adopted World Bank/IMF Structural Adjustment Programme (SAP). One of the Objectives was to achieve realistic exchange rate policy through establishment of foreign exchange market (FEM) so as to increase the cost of imports, reduce excess import spending and subsequently enhance GDP growth. The abolition of the bretton wood system of pegged exchange rate

in 1973 and subsequent adoption of SAP in 1986, floating exchange rate regime was sanctioned. The naira was allowed to drift and its value in relation to a dollar determined by forces of supply and demand of foreign exchange, though with little intervention from the government.

According to Obi, Gobna and Abu (2010) some of the programmes adopted to ensure a stable exchange rate for the naira are: Inter-bank Foreign Exchange Market (IFEM), Second-Tier Foreign Exchange Market (SFEM), Dutch Auction System (DAS), Autonomous Foreign Exchange Market (AFEM), Bureau De Change (BDC) among others. It is important to note that failure and inability of each policy led to adoption of another. In the past three decades, despite efforts by the monetary authority to achieve stable exchange rate also avoiding misalignment and fluctuations in the value of naira, it continued to depreciate as crude oil price fluctuate. The co-movement is shown by crude oil price and foreign exchange rate data from 1986 to 2015.

From 1986 to 1993 as crude oil price changes, the Naira depreciates relative to dollars, became stable from 1994 to 1998 and continued to depreciate till 2015. For instance, the sharp fall in the price of crude oil from 105.87 dollars per barrel in 2013 to 96.29 dollars per barrel in 2014 further depreciated the Naira exchange rate from N157.311 per dollar to N158.553 per dollar respectively. Osuji (2015) opined that this led the monetary authorities to devalue the Naira twice between September 2014 and June 2015 after it was no longer sustainable to continue the defense of the Naira by depleting the Nigeria's foreign exchange reserves. Oil prices and exchange rates data provided by World Bank development indicators revealed that, shortly after the adoption of SAP in 1986, the Nigerian annual GDP growth rate fell to a record low of -8.754 percent in 1986, peaked at 12.766 percent in 1990 and remained below that peak until 2004 when the GDP growth rate went up a record high of 33.736 percent. Since then, the Nigerian economy keeps shrinking to a GDP growth rate of -1.541 percent in 2016. The fall in GDP growth of the Nigerian economy because of crude oil price and naira exchange rate movements as led to the reduction in government revenue, increase in prices of goods and has plunge Nigerian economy into recession.

Given the inability of monetary authorities to achieve realistic exchange rate policy even after adopting SAP and constant fluctuations in the value of the naira sometimes occasioned by swings in crude oil price in the international market, this paper seek to investigate the impact oil price volatility has on exchange rate in Nigeria.

Research Hypothesis

$\boldsymbol{H_0}$**:** There is no significant relationship between crude oil price volatility and real exchange rate.

$\boldsymbol{H_0}$**:** There is no causality between crude oil price volatility and real exchange rate.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Literature Review

Exchange rate and crude oil price are important research variables in recent times; both generate significant impact on macro-economic variables like unemployment, interest rate, inflation, international trade and above all economic growth. The linkage between them has gained great importance in literature since the first oil shock in 1973/74, when lots of developing countries moved to managed floating exchange rate from fixed exchange rate by adopting SAP. Enormous literature tries to link crude oil prices to real exchange rates of developing and developed economies (Englama, Duke, Ogunleye, & Ismail, 2010). The other distinguishing category of discussion centers on whether the countries are either net oil exporter or net oil importer.

Globally, Buetzer, Habib and Straca (2012) studied to know whether crude oil price shocks important for world foreign exchange rate configurations. The study used data for nominal, real exchange rates and exchange rate market pressure index of 44 emerging and advanced countries. The study employed Vector Autoregressive (VAR) technique and discovered no proof that exchange rate of crude oil exporting countries appreciates in relation to those of crude oil importing countries after the shocks that increase real crude oil price. On the other hand, crude oil exporting countries experienced exchange rate appreciation due to oil demand shocks which was solved by saving huge foreign reserves.

In Russia, Rautava (2004) examined the nexus between real exchange rate and crude oil prices. The study used co-integration and VAR on quarterly data between 1995 and 2001. The findings revealed that Russian economy was significantly influenced by the fluctuation in real exchange rate and international crude oil prices in the short run impact and long run equilibrium condition. To support finding of Rautava (2004), Sosunov and Zamulin (2007) employed calibrated equilibrium model to investigate whether appreciation of the Russian currency between 1998 and 2005 can be attributed to rise in crude oil earnings. The results revealed that crude oil price only is not sufficient enough to justify why the Russian ruble appreciate devoid of stable rise in international crude oil price.

Similarly, Ito (2010) investigated influence of crude oil price volatility on macroeconomic activities in Russia. The study employed VAR model to analyze quarterly time series data from 1994:Q1 to 2009:Q3. The result revealed that 1 per cent rise (fall) in crude oil prices makes exchange rate to depreciate (appreciate) by 0.17 per cent in the long run. It also showed that increased crude oil prices caused exchange rate to depreciate, GDP growth and high inflation.

Aziz (2009) investigated long run impact of crude oil price and interest rate differential on exchange rate using panel data of 8 economies from 1980 to 2008. These countries

were divided into net crude oil exporting economies (Canada, Malaysia and Denmark) and net crude oil importing economies (Japan, Switzerland, Pakistan, Cote d'Ivoire and South Africa). The study used different panel co-integration tests and found evidence of long run relationships among the variable. It also used pooled mean group estimator to discover that oil price exert significant and positive influence on foreign exchange rate of net oil importing economies.. Conversely, the result revealed that no evidence of co-integration between crude oil price and exchange rate in net crude oil exporting economies.

Komain (2015) investigated crude oil price and exchange rate nexus in Thailand. The study employed monthly data between July 1997 to December 2013 and used co-integration and bi-variate GARCH technique of analysis. The result revealed that no co-integration and causality between the two variables but rise in volatility of crude oil price prompt real foreign exchange rate volatility to also rise.

Ahmed, Qaiser and Yaseen (2016) studied exchange rate volatility and real oil price fluctuation nexus in Pakistan. It was carried out to know factors that determine exchange rate and the extent crude oil price fluctuations impact on real foreign exchange rate. The study used Johansen co-integration and vector error correction model (VECM) on quarterly data from 1983:Q1 to 2014:Q2. The results revealed that real foreign reserves, real exports, productivity differential, interest rate differential and crude oil prices are important variables that determines exchange rate while real crude oil price volatility, consumer price index volatility and real foreign reserves volatility have positive effect on real foreign exchange rate volatility respectively.

In Indian, Kaushik, Nag and Kamal (2014) investigated the impact of crude oil price changes on foreign exchange rate of the rupee relative to a dollar. The study developed a monetary theory of exchange rate determination that incorporates real domestic money balances, real foreign money balances, domestic GDP and foreign GDP, real domestic crude oil price and interest rate differentials. The study employed error correction model on quarterly data from 1996 to 2012. The estimated results revealed domestic real money balances, domestic real GDP, and foreign real GDP are determinants of real exchange rate in India.

In Nigeria, Olomola (2006) empirically examined relationship between crude oil price shocks and economic activities using vector autoregressive model on quarterly time series data from 1970 to 2003. Variables used are industrial crude oil price, output (proxy for real Gross Domestic Product), money supply, consumer price index (proxy for inflation rate) and exchange rate (RER) and. The result showed that crude oil price induce exchange rate significantly but do not influence industrial output and consumer price index in Nigeria. It was concluded that there is presence of 'Dutch Disease' in Nigeria because increase in international crude oil price attracted huge wealth to the country thereby making the Naira to appreciate against the U.S dollar and finally increasing demand for non-tradable.

To support the study of Olomola (2006), Adeniyi, Omisakin, Yaqub and Oyinlola (2012) employed generalized autoregressive conditional heteroscedasticity (GARCH) and exponential GARCH (EGARCH) techniques to examine crude oil prices and exchange rates link sin Nigeria. It used daily frequency data from January 2, 2009 to September 28, 2010. The results depict that increase in crude oil price result appreciate the naira against dollar. The study also establishes asymmetric effect concerning size of negative and positive crude oil price shocks.

Apere and Ijomah (2013) examined impact of crude oil price volatility on macro-economic activities in Nigeria. The study employed lag augmented VAR (LA-VAR) models, EGARCH and impulse response function. The study used annual data of real crude oil price, inflation, real exchange rate, interest rate, government expenditure and real GDP from 1970 to 2009. The result revealed unidirectional causality between real exchange rate, interest rate and crude oil price. The causality was from crude oil price to interest rate and foreign exchange rate. Conversely, no significant relationship was discovered among crude oil price and GDP.

Osuji (2015) also complemented these findings by investigating crude oil price and foreign exchange rate causality in Nigeria. The study used 420 observations of monthly data from 2008:M1 to 2014:M12. The study used ordinary least squares (OLS) and VAR model, the result revealed that crude oil price significantly affect exchange rate compared to imports. It also showed unidirectional causality from crude oil prices to exchange rates and from crude oil prices to foreign reserve exist. The study concluded that Nigeria should change her structure of international trade to reduce import dependence and enable monetary authorities to manage both her foreign reserves and exchange rate.

Onoja (2015) also empirically examined the link between exchange rates and crude oil prices in Nigeria. The study was carried out to know if there is positive relationship between exchange rate and oil prices as revealed by the findings of previous research and if crude oil prices can be responsible for long run exchange rate movement. The study used quarterly data from 1981:Q1 to 2009:Q4 and error correction method (ECM). It was revealed that movements in exchange rate were caused by changes in permanent components and that oil price volatility do not have effect on exchange rate in the short run. The study therefore concluded that this may be because crude oil is not priced in naira.

Englama et al. (2010) studied impact of crude oil price volatility, demand for foreign exchange and external reserves on exchange rate in Nigeria. The study used vector error correction (VEC) and co-integration test on monthly data from 1999:M1 to 2009:M12. The result revealed 1 per cent permanent rise in crude oil price increase real exchange

rate volatility by 0.02 per cent in the short run and 0.54 per cent in the long run.

To the best of my Knowledge, this study differs from previous studies on impact of oil price volatility on exchange rate done for Nigeria and other economies (Ito, 2010; Apere and Ijomah, 2012; Onoja, 2015; and Englama et al., 2010). It employed annual data and autoregressive distributed lag (ARDL) model. This study attempted to add to existing knowledge by employing ARDL bounds testing procedure and generate data for crude oil price volatility for Nigeria. Similarly, this study considered only the Post-SAP impact era so as to give proper understanding of the challenges of crude oil price and foreign exchange rate movement.

2.2 Theoretical Framework

This study provides two sets of theoretical models that describe mechanisms that link real exchange with terms of trade of commodity exporting countries. The model assumed that commodity is completely exported and its price determined internationally. The second model captures the various theories of exchange rate determination.

2.2.1 Commodity Currencies and Exchange Rate Theory

Cashin, Luis and Sahay (2004) looked at small-open domestic economy in which 2 goods are produced; primary commodity meant for export (X) and non tradable good (N). Production is done using technology (constant returns to scale), with labour as primary input. It presumed free mobility of labour across different sectors of the economy such that nominal wage rate (w) are the same. Thus, real wage rate must equate marginal productivity at equilibrium.

$$a_N = \frac{w}{P_N} \text{ and } a_X = \frac{w}{P_X} \qquad 2.1$$

Where:

a_N(resp. a_X) = productivity in the non tradable good sector,

P_N and P_X = are the corresponding prices.

Equation 2.2 is in conformity with Balassa-Samuelson outcome that opined that relative price of non tradable good in relation to primary commodity price is determined by supply conditions:

$$P_N = \frac{a_X}{a_N} P_X \qquad 2.2$$

Equation 2.2 revealed that growth in terms of trade will raise wages in X sector, resulting to rise in price of non-traded goods, given that nominal wage changes stretch to entire economy. There is free mobility of labor between sectors; consequently prices can be presented the same way as in domestic economy:

$$P_N^* = \frac{a_I^*}{a_N^*} P_I^* \qquad 2.3$$

Real exchange rate is expressed as function of foreign price of domestic basket of consumption (EP) relative to foreign price (P^*).

$$\text{RER} = \frac{EP}{P^*} \qquad 2.4$$

Here, increase in E implies real exchange rate appreciation. Consumer price index is expressed as:

$$\text{P} = (P_N)^{\gamma}(P_T)^{1-\gamma} \qquad 2.5$$

γ is proportion of non tradable goods in consumer basket. Thus, real exchange rate is expressed as function of terms of trade:

$$\text{RER} = \left(\frac{a_X a_N^*}{a_I^* a_N} \frac{P_X^*}{P_I^*}\right)^{\gamma} \qquad 2.6$$

Where:

$\frac{a_X a_N^*}{a_I^* a_N}$ = BS and $\frac{P_X^*}{P_I^*}$ = TOT

Where TOT is terms of trade measured in foreign prices, and BS is the Balassa-Samuelson effect. Overall, equation (2.6) shows that changes in terms of trade result to variation in real exchange rate. One of the advantages of this model is it simplicity, however, it can give limited results because of omitted mechanisms. In fact, the model did not attend to the problem of income effect. Thus, rise in terms of trade accrues great wealth to producers that result to income and substitution effects.

2.2.2 Monetary Theory of Exchange Rate

The monetary approach to exchange rate emerged first in the 1950s as a model of balance of payments and later refocused on exchange rates. It was originally propounded by Polak in 1957 and later redefined by Mundell (1968, 1971), Johnson (1972, 1975, 1976, and 1977) and Johnson and Frenkel in1976.

The monetary model of exchange rate attempts to explain exchange rate fluctuations in terms of changes in supply and demand for money between countries (Nyong, 2015). This model opined that rise in money supply will cause exchange rate to depreciate because of induced inflationary pressures. An increase in real GDP with fixed nominal supply of money will cause prices to plummet resulting to appreciation of exchange rate. Similarly, increase in domestic interest rate in relation to foreign interest rate lowers demand for money and raises prices (with a given stock of money).

The monetarist theory of exchange rate determination combines the quantity theory of money (that is, demand for money) with purchasing power parity (PPP) hypothesis to indentify causal factors affecting the level of exchange rate.

Let $M_1^d = P_1^{c1} Y_1^{c2} R_1^{c3}$ 2.7

$M_2^d = P_2^{c1} Y_2^{c2} R_2^{c3}$ 2.8

$P_1 = eP_2$ 2.9

Where M_1^d is nominal money demand in home country, M_2^d is nominal money demand for foreign country, P_1 and P_2 are domestic and foreign price level respectively, Y_1 and Y_2 are domestic and foreign real income, R_1 and R_2 are domestic and foreign interest rates respectively.

Dividing equation (7) by (8), using equation (9) and taking logs we have:

$$\frac{M_1^d}{M_2^d} = \frac{P_1^{c1}}{P_2^{c1}} \frac{Y_1^{c2}}{Y_2^{c2}} \frac{R_1^{c3}}{R_2^{c3}} \quad 2.10$$

$$c_1\text{Loge}=\text{Log}(M_1^d/M_2^d)- c_2\text{Log}(Y_1/Y_2)- c_3\text{Log}(R_1/R_2) \quad 2.11$$

$$\text{Loge}=b_1\text{Log}(M_1^d/M_2^d)- b_2\text{Log}(Y_1/Y_2)- b_3\text{Log}(R_1/R_2) \quad 2.12$$

Where: $b_1 = 1/c_1$, $b_2 = c_2/c_1$, $b_3 = c_3/c_1$

From equation (2.15), Nyong (2015) specified three basic implications of exchange rate adjustments are derived. These include the following; an increase in supply of money in relation to foreign supply of money depreciates the domestic currency, increase in real GDP or productivity in relation to foreign productivity appreciate the domestic currency, increase in domestic interest rate in relation to foreign interest rates depreciate the domestic currency.

The theoretical framework adopted for this study was commodity currency and exchange rate model and monetary theory of foreign exchange rate determination. The choice of the commodity currency and exchange rate model was informed by the fact that it describes the mechanism that links oil price to foreign exchange rate of crude oil exporting countries. The monetary theory on the other hand contains variables that could help in the proper understanding of the subject matter.

III. RESEARCH METHODOLOGY

This study adopted descriptive and econometric design to study impact of crude oil price volatility on foreign exchange rate. Descriptive design was based on various descriptive statistical tools such as mean, median, maximum and minimum values, skewness, and kurtosis. The econometric design on the other hand employed econometric tools to process the variables in the model for the purpose of obtaining results that could be interpreted for meaningful conclusion. In specific terms, the study employed Autoregressive Distributed Lag (ARDL) bounds testing procedure as its estimation technique.

However, before the estimation of the ARDL model, the study subjected the data collected for each variable to stationarity test for the presence or absence of unit root. This study employed Augmented Dickey-Fuller (ADF) test proposed by Dickey and Fuller in 1979 with intercept and trend. The bounds testing procedure was used to test for co-integration. Pair-wise granger causality test was conducted to know direction of causality between crude oil price volatility and real exchange rate.

3.1 Model Specification

To investigate the relationship between variables, econometricians express this relationship in mathematical form, that is, to specify the model upon which the economic phenomenon will be explored and analyzed empirically (Gujarati, 2009). In this regard, this study made use of two equations. Equation one captured the link between real exchange rate and crude oil price volatility to achieve objective one, while equation two captured the causality between them to achieve objective two. The theoretical underpinning of this work was based on an eclectic model that includes the commodity currencies and exchange rate model and monetary theory of exchange rate determination. The United States of America (USA) was chosen as the foreign country because it constitutes one of Nigeria's major trading partners and crude oil prices are usually expressed in U.S dollars.

Based on the theories upon which this study was anchored, real exchange rate was expressed as function of domestic (Nigeria) money supply, foreign (U.S.A) money supply, domestic GDP, foreign GDP, interest rate differentials between Nigeria and the United States, Nigeria Consumer Price Index (proxy for inflation) and volatility of crude oil price (crude oil terms of trade proxied by crude oil price volatility).

Equation 1: Exchange Rate Equation

This equation captures objective one. Mathematically, it is represented as:

$$RER_{it}=\text{f}(M_1, USM_2N, Y_1, \text{US}Y_2N, \text{INRD}, \text{NCPI}, \text{VCOP}) \quad 3.1$$

Where RER is real exchange rate (national currency per US dollar), $M_1$is Nigeria money supply in millions of naira, USM_2N is U.S money supply in millions of naira, $Y_1$is Nigeria GDP in millions of naira, USY_2N is U.S GDP in millions of naira, INRD is interest rate differential between Nigeria and U.S.A (i_1-i_2), NCPI is Nigeria Consumer Price Index, VCOP is volatility of crude oil price (crude oil terms of trade proxied by crude oil price volatility)

Equation (3.1) can be presented in a linear for as:

$$RER_t=\beta_0+\beta_1 M_1+\beta_2 USM_2N+\beta_3 Y_1+\beta_4 \text{US}Y_2N + \beta_5 \text{INRD} + \beta_6 NCPI + \beta_7 VCOP + \mu_1 \quad 3.2$$

Transforming equation (3.2) into Log form, we have:

$$\text{Log}RER_t=\beta_0+\beta_1 LogM_1+\beta_2 LogUSM_2N + \beta_3 LogY_1 + \beta 4 LogUSY2N+\beta 5 \text{INRD} + \beta 6 \text{LogNCPI} + \beta 7 \text{LogVCOP}+\mu 1 \quad 3.3$$

$\beta_1 <0$; $\beta_2 >0$; $\beta_3 >0$; $\beta_4 <0$; $\beta_5 <0$; $\beta_6 <0$; $\beta_7 <0$

Where β_0 to β_7 are parameters to be estimated, μ_1 is the error term.

Equation 2: Causality Equation

This equation captures objective two and it is informed by the granger causality test. This is expressed as:

$$RER_t=\alpha_1+\varphi_1 RER_{(t-1)}+\ldots.+\varphi_1 RER_{t-1}+\delta_1 VCOP_{(t-1)}+\ldots.+\delta_1 VCOP_{t-1}+\varepsilon_t \quad 3.4$$

$$VCOP_t=\alpha_2+\omega_1 VCOP_{(t-1)}+\ldots..+\omega_1 VCOP_{t-1}+\gamma_1 RER_{(t-1)}+\ldots.+\gamma_1 RER_{t-1}+V_t \quad 3.5$$

Where RER_t is current real exchange rate, $VCOP_t$ is current volatility of real crude oil price, α_1 and α_2 are intercepts, φ_1, δ_1, ω_1 and γ_1 are parameters to be estimated, ε_t and V_t are error terms.

TABLE 1 Description of Variables in the Model

Variable	**Definition**	**A priori Expectation**
Real Exchange Rate (RER)	The rate at which one country's real goods and services can be changed into those of another.	Dependent variable
Nigeria Money Supply (M_1)	Broad money (M2). Measure of money supply that includes more than just coins and currency. It includes demand deposits at commercial banks.	M_1 <0
U.S Money Supply (USM_2N)	Broad money (M2). Measure of money supply that includes more than just coins and currency. It includes demand deposits at commercial banks in the U.S.	USM_2N >0
Nigeria Gross Domestic Product (Y_1)	Measure of output in an economy; an indicator of economic performance.	Y_1 >0
U.S Gross Domestic Product (USY_2N)	Measure of output in an economy; an indicator of economic performance.	USY_2N <0
Interest Rate Differential (INRD)	Lending rate of Nigeria minus the lending rate of the United States.	INRD <0
Nigeria Consumer Price Index (NCPI)	This is a measure of inflation in an economy.	NCPI <0
Volatility of Crude Oil Price (VCOP)	Statistical measure of the amount of fluctuation in oil prices within a period of time. Calculated using a GARCH (1,1) model.	VCOP <0

Source: compiled by the author, 2017

This study made use of secondary data (annual) series from 1986 to 2015, when Nigeria moved from pegged exchange rate regime to managed float regime shortly after adoption of Structural Adjustment Program (SAP) in 1986 to the current reality of crude oil price and exchange rate fluctuations. Data were gotten from World Bank Development Indicators site, CBN statistical bulletin, International Monetary Fund (IMF) financial statistics and OPEC annual statistical bulletin. The data for volatility of oil price was derived from annual crude oil price using Generalized Autoregressive Conditional Heteroskedasticity (GARCH 1, 1) model.

3.2 Estimation Technique

The estimation procedures involved determining relationship between the endogenous and exogenous variables captured in the exchange rate equation. It also involved investigating the direction of causality between exchange rate and volatility of crude oil price. Specifically, ARDL technique introduced by Pesaran, Smith and Shin (2001) was employed to estimate the exchange rate equation. However, considering nature of time series data that was captured in this study and the danger of a spurious regression results, the time series data were subjected to the test of stationarity to be sure that variables are not integrated of order I(2). This is because calculated f-statistics given by Pesaran et al. (2001) can only be applicable when variables are integrated of order I(0) and I(1) before they were used to estimate the ARDL model. Co-integration test was conducted using ARDL bounds testing procedure to determine long run equilibrium relationship between the endogenous variable (RER) and exogenous variables (M_1, USM_2N, Y_1, USY_2N, INRD, NCPI and VCOP) for the first equation accepting the Wald test. Error correction mechanism was obtained by adding one period lagged variable of error term to the estimated model.

IV. DATA PRESENTATION AND ANALYSIS OF RESULT

4.1 Presentation and Analysis of Descriptive Data

These statistics were employed to quantitatively summarize characteristics of a collection of information about the data used in this study. This study used measures such as maximum and minimum values, skewness, kurtosis, mean, median, and Jarque- Bera test. The maximum value is used to identify the largest data value in a time series. It is used to identify a possible outlier or data entry error. Minimum value on the other hand was used to identify the smallest value in the data set. The kurtosis value indicates how the peak and tails of a distribution differ from the normal distribution. In other words, kurtosis measures the "tailedness" of probability distribution of real random variable. The kurtosis of any standard normal distribution is 3, thus, higher kurtosis values indicate a higher, sharper peak and means more of the variability is due to few extreme differences from the mean, rather than a lot of modest difference from the mean and vice versa. On the other hand, skewness describes asymmetry from normal distribution in a set of data. It can either be negative or positive, depending on whether data points are skewed to the right and positive or left and negative of the data average.

In this section, the descriptive statistic result was used to get a first impression on the extent to which oil price volatility and other variables included in the exchange rate equation might have influenced exchange rate. The impact was investigated in terms of real exchange rate, Nigeria money supply, U.S money supply, Nigeria income, U.S income, interest rate differential and volatility of crude oil price.

TABLE 2 Descriptive statistics

	LRER	LM1	LUSM2N	LY1	LUSY2N	INRD	LNCPI	LVCOP
Mean	5.078904	17.00835	19.61893	17.36228	19.92167	12.64200	3.104350	8.016021
Median	5.123643	16.7273	20.46972	17.43756	20.82910	12.53150	3.483276	8.039910
Maximum	5.633632	20.3537	21.86095	20.66728	21.96771	25.65000	5.068546	12.86607
Minimum	4.134350	13.85095	15.64045	14.51293	15.90189	1.626000	-0.131248	2.989714
Std. Dev.	0.412518	1.956873	1.849017	1.819711	1.780576	4.461516	1.605918	2.965578
Skewness	-0.773917	0.113055	-0.527661	0.076936	-0.659065	0.381621	-0.687743	-0.028327
Kurtosis	2.846416	1.944904	1.932336	1.906040	2.138912	4.678014	2.199035	1.819927
Jarque-Bera	3.024226	1.455441	2.817013	1.525531	3.098671	4.247836	3.166882	1.744729
Probability	0.220444	0.483009	0.244508	0.466375	0.212389	0.119562	0.205268	0.417962
Sum	152.3671	510.2505	588.5679	520.8685	597.6500	379.2600	93.13051	240.4806
Sum Sq. Dev.	4.934966	111.0512	99.14704	96.02913	91.94306	577.2487	74.79022	255.0450
Observations	30	30	30	30	30	30	30	30

Source: computed by the author

Table 2 shows that within the period of study, maximum and mean values for LRER, LM1, LUSM2N, LY1, LUSY2N, INRD, LNCPI and LVCOP stood at 5.633632 (5.078904), 20.3537 (17.00835), 21.86095(19.61893), 20.66728 (17.36228), 21.96771 (19.92167), 25.65000 (12.64200), 5.068546(3.104350) and 12.86607(8.016021) respectively. This implies that these variables in the exchange rate equation are important in explaining impact crude oil price volatility has on exchange rate, given excess their maximum values has over their mean values. The Jarque-Bera, Kurtosis, and Skewness of INRD are higher than those of other variables, suggesting the probable impact of interest rate differentials on other variables in the exchange rate equation.

4.2 Presentation and Analysis of Econometric Data

Unit Root Test Result (Exchange Rate Equation)

To achieve objectives of this study, stationarity status of the variables (LRER, LM1, LUSM2N, LY1, LUSY2N, LNCPI and INRD) in the exchange rate equation were determined with the exception of volatility of crude of price (VCOP). This is because the data for crude oil price volatility was generated through a stochastic process using generalized autoregressive conditional heteroskedasticity (GARCH 1, 1). Stationarity test was conducted to be sure that variables employed are not integrated of order I(2), to avoid spurious results. The f-statistic provided by Pesaran, Smith and Shin (2001) will break down if variables are order I(2). The reason is that ARDL bounds testing technique presume variables are order I(0), I(1) or mixture of both. Stationarity test was done using Augmented Dickey-Fuller (ADF) with constant (intercept) and trend. Results obtained are represented in table 4.2: The unit roots results presented in table 4.2 reveal that variables are stationary at different levels and therefore the co-integration test of Engel-Granger (1987), Johansen (1988) and Johansen- Juselieus (1990) cannot be used to test for long run relationship between the variables, since these tests demand that the variables must be stationary at the same levels.

TABLE 3 Augmented Dickey Fuller (ADF) Unit Root Test Results

Variables	Level	1st Difference	Order of Integration
LRER	-2.549215	-5.118545*	I(1)
LM1	-1.982634	-5.196399*	I(1)
LUSM2N	-2.152042	-5.768094*	I(1)
LY1	-1.657474	-5.417555*	I(1)
LUSY2N	-2.178395	-5.782378*	I(1)
INRD	-4.627740*	----------	I(0)
LNCPI	-7.748659*	----------	I(0)

Test critical values at level: 1 per cent= -4.309824, 5 per cent= -3.574244, 10 per cent= -3.221728

Test critical values at 1st difference: 1 per cent= -4.323979, 5 per cent= -3.580623, 10 per cent= -3.225334

Source: computed by the author

Correlation Matrix

Having established the absence of unit roots in the variables, the study went further to find out the relationship between endogenous variable (LRER) and exogenous variables (LM1, LUSM2N, LY1, LUSY2N, INRD, LNCPI and VCOP) and also between the independent variables themselves. The correlation matrix result is presented in table 4 below.

From the correlation matrix result presented in table 4, the variables of interest exhibited a negative relationship. In specific term, the result indicates that there is perfect-negative correlation between volatility of crude oil price (VCOP) and real exchange rate (RER). The reported coefficient between LRER and LVCOP is -0.084361, which implies that the more volatile crude oil price is, the more value of the naira keeps depreciating.

TABLE 4 Correlation matrix

	LRER*	**LM1**	**LUSM2N**	**LY1**	**LUSY2N**	**INRD**	**LNCPI**	**LVCOP***
LRER*	1.000000	-0.486256	0.101242	0.298118	0.103751	0.440908	-0.138673	-0.084361
LM1	-0.486256	1.000000	-0.527759	0.131125	-0.512952	-0.095280	-0.383487	-0.442918
LUSM2N	0.101242	-0.527759	1.000000	-0.305153	0.998152	0.353708	0.968101	0.964460
LY1	0.298118	0.131125	-0.305153	1.000000	-0.331030	0.152996	-0.406207	-0.219563
LUSY2N	0.103751	-0.512952	0.998152	-0.331030	1.000000	0.375400	0.970336	0.952301
INRD	0.440908	-0.095280	0.353708	0.152996	0.375400	1.000000	0.279977	0.238166
LNCPI	-0.138673	-0.383487	0.968101	-0.406207	0.970336	0.279977	1.000000	0.964988
LVCOP*	-0.084361	-0.442918	0.964460	-0.219563	0.952301	0.238166	0.964988	1.000000

Note: * represent the variables of interest

Source: computed by the author

Optimal Lag Selection

Having established the correlation among the variables, the study proceeded to ascertain if the variables are co-integrated using ARDL bounds testing procedure. Before the bounds test, appropriate lag length was selected for the method to give accurate results and avoid the problem of autocorrelation in the residual term. This study used the vector autoregressive (VAR) lag order selection criteria to select optimal lags to be included in the model based on four different criteria.

Table 5 reported optimal lag length of two (2) out of maximum lag lengths of 3 lag as selected by the four different criteria because 2 lags has the minimum values. After establishing the number of lags to be used in the exchange rate equation, the study went further to estimate the ARDL bounds (Wald) test and the result are presented in table 6 below.

TABLE 5 Optimal lag(s) selection criteria

Lag	FPE	AIC	SIC	HQ
0	1.49e-06	9.284507	9.665137	9.400869
1	2.76e-15	-11.00772	-7.582048	-9.960456
2	1.00e-2*	-19.53365*	-20.73185*	-25.22440*

*Indicates lag selected by each criterion

Source: computed by the author

TABLE 6 Bound Test of Co-integration

ARDL Bound Test of Co-integration

Lag=2			F-statistic=5.872337*					
Critical Value Bound of the F-statistics								
K	10%		5%		2.5%		1%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
7	2.03	3.13	2.32	3.5	2.6	3.84	2.96	4.26

Note: * implies that computed f-statistic is above upper bound values

Source: computed by the author

Table 6 presents result of ARDL bound testing co-integration approach for exchange rate equation. The first step in this technique is to compare result of calculated f-statistic with it critical values given in the study of Pesaran et al. (2001). Consequently, f-statistic of 5.872337 which is calculated at k=7 (number of independent variable) exceeds

the upper critical value at 10 per cent, 5 per cent, 2.5 per cent and 1 per cent. Therefore, null hypothesis of no co-integration was rejected without considering whether they are integrated of the same order or not. Thus, it was concluded that long run relationship exist among real exchange rate, Nigeria money supply, United States money supply in naira, Nigeria GDP, U.S GDP in naira, interest rate differential, Nigeria CPI and volatility of crude oil price. The next step is to determine marginal impacts of volatility of oil price on exchange rate.

Estimated Long-Run Exchange Rate Equation Using ARDL Bounds Approach

Using ARDL (2, 0, 2, 1, 0, 2, 1, 1) model automatically selected based on Akaike Information Criterion (AIC), result obtained are presented below. The estimated coefficients show long run elasticity of the variables. In table 7, long run coefficient of Nigeria money supply (LM1) is significant and negative at 1 per cent level. The sign is in line with theoretical assertion that increases in supply of money in domestic economy, will depreciation value of the domestic currency. The coefficient of LM1 (-0.12) means that 1 percent increase in supply of money in Nigeria will depreciate value of the naira by 0.12 percent. This implies that money supply has considerable effect on real exchange rate. Long run coefficient of U.S money supply (LUSM2N) converted to naira is significant at 10 per cent level and positive. The coefficient of 0.26 for U.S money supply, all things being equal, indicates that 1 percent increase in U.S money supply will appreciate the naira by 0.26 percent. This means U.S money supply exerts little influence on Nigeria's exchange rate. This is in conformity with monetary approach of exchange rate determination. The long run coefficient of volatility of crude oil price (VCOP) which is derived from crude oil price (proxy for terms of trade) is significant and negative at 1 per cent level. The coefficient -14.17 for VCOP, all things being equal, imply that 1 per cent increase in crude oil price volatility depreciate the naira by -14.17 per cent. This is in line with the commodity currency and exchange rate theory which states that changes in terms of trade, will lead to swings in real exchange rate. This means that volatility of crude price exert a very strong negative impact on real foreign exchange rate in long run.

Long run coefficient of Nigeria GDP (Y1) is significant at 1 per cent level and positive. This support the assumption of monetary theory of exchange rate determination which states that increase in domestic output, appreciate domestic currency. The coefficient of 13.63 for Nigeria GDP implies that 1 per cent increase in Nigeria's GDP; appreciate the naira by 13.63 per cent in the long run. This therefore means that domestic GDP exert significant impact on exchange rate in Nigeria.

U.S GDP converted to naira (USY2N) has long-run coefficient of 0.11, positive and statistically insignificant. This result indicates that when U.S GDP goes up by I percent, Nigeria's naira exchange rate also appreciates by 0.11 percent. Obviously, it is expected that a rise in U.S GDP will depreciate the naira exchange rate because more dollars will be demanded to import U.S increased output. However, the result obtained here indicates the reverse.

The long run coefficient of interest rate differentials is significant at 1 per cent level and negative. The negative signed INRD supports theoretical conclusion that, increase in domestic lending interest rate in relation to foreign lending interest rate will depreciate domestic currency. INRD coefficient of -0.26 implies that 1 per cent increase in interest rate differentials; depreciate the naira exchange rate by 0.26 percent. This is because Nigeria lending interest rate is high relative to U.S lending interest rate and therefore discourages potential investors from borrowing. Lastly, the long run coefficient of Nigeria consumer price index (NCP) is significant at 1 per cent level and positive. This result showed that 1 per cent increase in CPI, exchange rate will increase by approximately 3.10 percent. Theoretically, it is expected that rise in CPI should depreciates the naira relative to dollars, but the result obtained showed otherwise. One possible reason for this could be due to small data points used in this study. It covers the period 1986 to 2015 which could be seen as relatively small. Hence, use of monthly or quarterly data could have helped achieve correct negative theoretical sign.

TABLE 7 Estimated Long Run Coefficients Based on ARDL Model

ARDL (2, 0, 2, 1, 0, 2, 1, 1) Chosen Based on Akaike Information Criteria Dependent Variable (LRER)				
Variable	Coefficient	Std. Error	t-statistic	Probability
LM1n	-0.119835	0.007908	-15.153016*	0.0000
LUSM2N	0.258463	0.142102	1.818856**	0.0962
LOG(VCOP)	-14.169058	0.833702	-16.995348*	0.0000
LY1	13.626125	0.816022	16.698242*	0.0000
LUSY2N	0.107392	0.129357	0.830200	0.4241
INRD	-0.255273	0.015577	-16.387464*	0.0000
D(LNCPI)	3.100256	0.228967	13.540210*	0.0000
C	-0.788303	1.065118	-0.740109	0.4747

Note: * and ** imply significance at 1 per cent and 10 per cent level

Source: computed by the author

Results of Error Correction Mechanism (ECM) for Selected ARDL Model

The co-integrating equation (CoinEq (-1)) in table 4.7 represents the error correction mechanism. In specific terms, ECM provides way of reconciling short run behavior of macroeconomic variables with their long run behavior. The presence of co-integration between the variables requires estimation of ECM to determine dynamic behavior of exchange rate equation. The ECM variable captures short run dynamics and its coefficient measures speed of adjustment from short run disequilibrium to long run equilibrium in event of shocks to the system. Table 4.7 depicted the results of short run dynamic exchange rate equation.

The short run dynamic result above revealed that the estimated exchange rate passed the diagnostic tests. Durbin-Watson statistic of 2.809273 indicates no strong autocorrelation in the residuals. The overall regression is significant at 1 percent as can be seen from the R-Squared and the F-statistic. R-Squared of 0.998813 indicate about 99 per cent of variation in endogenous variable (RER) is explained by changes in exogenous variables. Also, an F-statistic value of 309.6700 suggests joint significance of the determinants in the ECM. Coefficients of variables used in this study provide interesting results because they maintain their correct signs as in the long run estimate, with the exception of coefficient of U.S money supply (LUSM2N) variable whose sign changed from positive to negative in the current period and positive in one period lag of LUSM2N. The coefficients indicate the short-run elasticities.

TABLE 8 Error Correction Estimate

ARDL (2, 0, 2, 1, 0, 2, 1, 1) Chosen Base on Akaike Information Criterion Dependent Variable (LRER)				
Variable	Coefficient	Std. Error	t-statistic	Probability
D(LRER(-1))	0.403631	0.376719	1.071438	0.3069
D(LM1)	-0.172829	0.013326	-12.969791*	0.0000
D(LUSM2N)	-0.163741	0.243010	-0.673803	0.5143
D(LUSM2N(-1))	0.807214	0.263863	3.059217**	0.0109
DLOG(VCOP)	-0.381771	2.001587	-0.190734	0.8522
D(LY1)	19.652016	0.009486	2071.674317*	0.0000
D(LUSY2N)	0.045121	0.243893	0.185003	0.8566
D(LUSY2N(-1))	-0.043643	0.303575	-0.143762	0.8883
D(INRD)	-0.372483	0.001914	-194.647210*	0.0000
D(LNCPI, 2)	0.023657	0.091834	0.257605	0.8015
CoinEq(-1)	-0.442231	0.086955	-5.585952*	0.0000

Cointeq=LRER-(-0.1198*LM1+0.2585*LUSM2N-14.1691*LOG(VCOP)+13.6261*LY1+0.1074*LUSY2N-0.2553*INRD+3.1003*D(LNCPI)-0.7883*C)

R-Squared=0.998813	Mean dependent var=5.085271
Adjusted R-Squared=0.997085	S.D dependent var=0.414146
S.E of regression=0.022358	AIC=-4.483275
Sum Squared resid=0.005499	Schwarz Criterion=-3.674436
Log likelihood=79.76585	Hannan-Quinn Criterion=-4.236005
F-statistic=309.6700	Durbin-Watson stat=2.809273
Prob (F-statistic)=0.000000	

Note: * and ** shows significance at 1 percent and 10 percent level

Source: computed by the author

The coefficient of one period lag of real exchange rate (RER) is not significant at 1, 5 and 10 per cent levels but positive. This indicates that one period lag of real exchange rate do not influence current period real exchange rates much.

The behavior of Nigeria money supply (LM1) is consistent with monetary theory of exchange rate determination which states that an increase in supply of money in the domestic economy will lead domestic currency to depreciation. Coefficient of LM1 is significant at 1 per cent

level and negative. Therefore, LM1 influences real exchange rate in the long and short runs. Short run coefficient of U.S money supply (LUSM2N) in naira is statistically not significant at 1, 5 and 10 per cent levels and negative. This implies that U.S money supply does not influence exchange rate in Nigeria in the short run. Similarly, one period lag of U.S money supply has positive sign and significant at 10 per cent level. It imply that one period lag of U.S money supply exert little influence on real exchange rate. The coefficients of volatility of crude oil price (VCOP) in the short run equation maintained it negative sign but became statistically not significant at 1, 5 and 10 per cent levels. This implies that in the short run, volatility of crude oil price cannot account for the fluctuation in real exchange rate in Nigeria. Coefficient of Nigeria GDP (Y1) in the short run is still significant at 1 per cent level and positive. This is in conformity with result of the long run equation discussed in previous section of this study. This reaffirms the significant role GDP plays in influencing exchange rate in Nigeria. The coefficient of U.S GDP in naira (LUSY2N) in the short run is positive and not significant. This implies that U.S GDP does not influence exchange in Nigeria in the short run. Similarly, one period lag of U.S GDP is also not statistically significant but negative.

The short run coefficient of interest rate differentials (INRD) is still significant at 1 per cent level and negative. This is in conformity with the long run result and the monetary theory of exchange rate determination which postulates that, increase in domestic interest rate in relation to foreign interest rate result to exchange rate depreciation. This also reaffirms the negative and significant role interest rate plays in influencing naira/dollar exchange rate.

The coefficient of Nigeria consumer price index (NCPI) is not significant at 1, 5 and 10 per cent levels in the short run but still positive which highlights its effect on real exchange rate. This contradicts result of the long run estimate that was significant at 1 percent level. This is because in theory, some level of inflation is necessary for an economy to grow and therefore do not influence exchange rate in the short run but does in the long run when it above certain threshold. Finally, estimated coefficient of error correction variables is statistically significant at 1 per cent level and correctly signed. From result in table 4.7, estimated coefficient of error correction mechanism is -0.442231. It reflects slow speed of adjustment to equilibrium after every shock. This is because about 44 per cent of disequilibrium from previous year's shock converges back to equilibrium in the current period.

Granger Causality Test

The ARDL approach reveals long run co-integration information among variables used, but do not indicate causality between them. Since long run estimates with correlation matrix suggested a negative and significant relationship between the two variables, it is expedient to know the direction of causality. After testing for short run dynamics, the study finally tested for causality between crude oil price volatility and real exchange rate.

The causality result presented in table 9 shows no causality between the variables of interest. This is because probability values of 8.4 and 95.8 percent are greater than 5 percent; hence, null hypothesis of no causality is accepted. This is because Nigeria does not have control over the price of crude oil; rather they sell at a given price determined by OPEC.

TABLE 9 Pair-Wise Granger Causality Test

Null Hypothesis	Obs	F-statistic	probability
VCOP do not Granger Cause RER	28	2.76954	0.0836
RER do not Granger Cause VCOP		0.04262	0.9584

Source: computed by the author

Post Estimation Test (Stability Test)

Since coefficients of the long run estimate using ARDL (2, 0, 2, 1, 0, 2, 1, 1) chosen base on Akaike Information Criterion revealed negative and significant link between crude oil price volatility and real exchange rates. Thus, it is important to know whether this relationship is stable or not. There are different test of stability that can be used to verify stability of the long run relationship, but this study employed the recursive residual tests that includes cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) statistics. CUSUM test helps to show if the coefficients of regression are changing systematically while CUSUMSQ test is helpful to showing if the coefficients of regression are changing suddenly. Figure 1 and 2 shows the CUSUM and CUSUM of squares statistics for stability of the relationship together with short run movement between crude oil price volatility and real exchange rate. Figure 1 showed plot of CUSUM stays within critical 5 percent bounds. The result also revealed that the coefficients are changing systematically. However, CUSUMSQ plot in figure 2 exceeds 5 percent critical bounds of parameter stability and therefore confirms the result obtained in the short run estimate. This indicates that relationship between crude oil price volatility and real exchange rate is not stable and coefficients are not changing suddenly.

Figure1 Test of Stability between Crude Oil Price Volatility and Real Exchange Rate

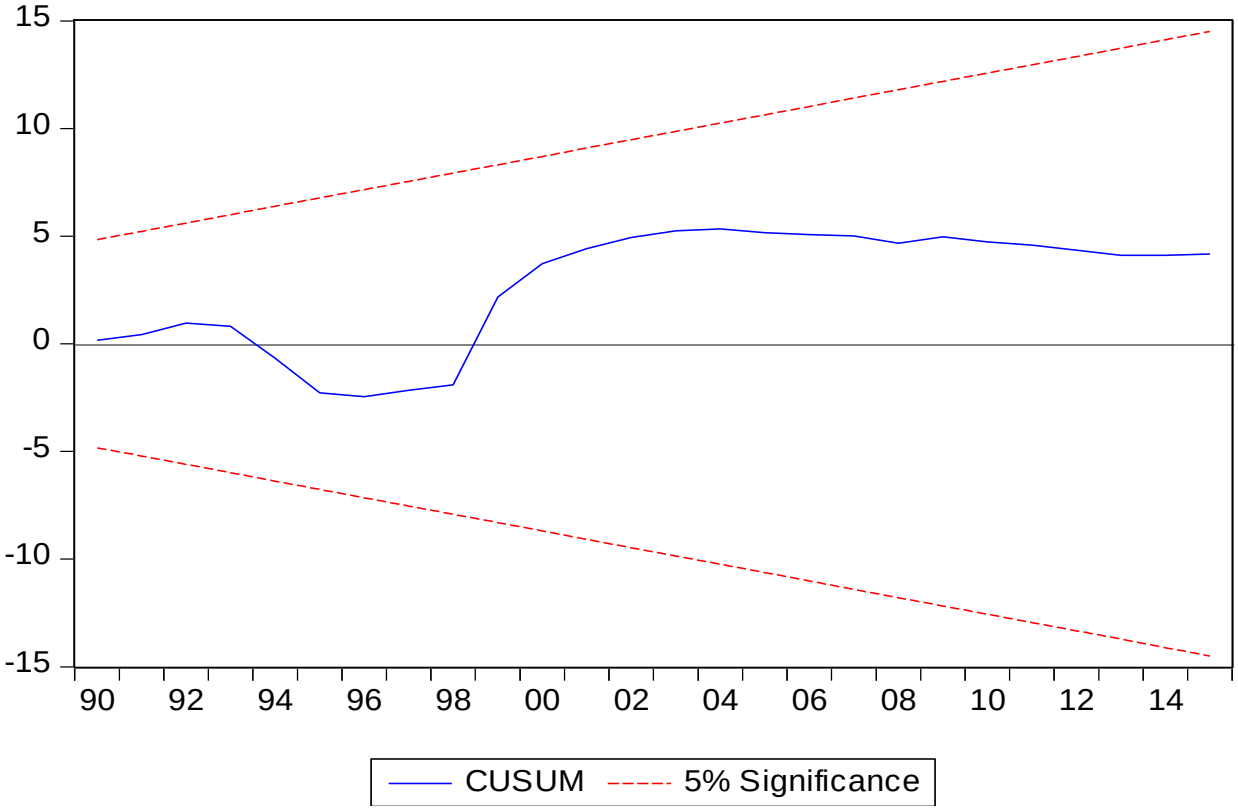
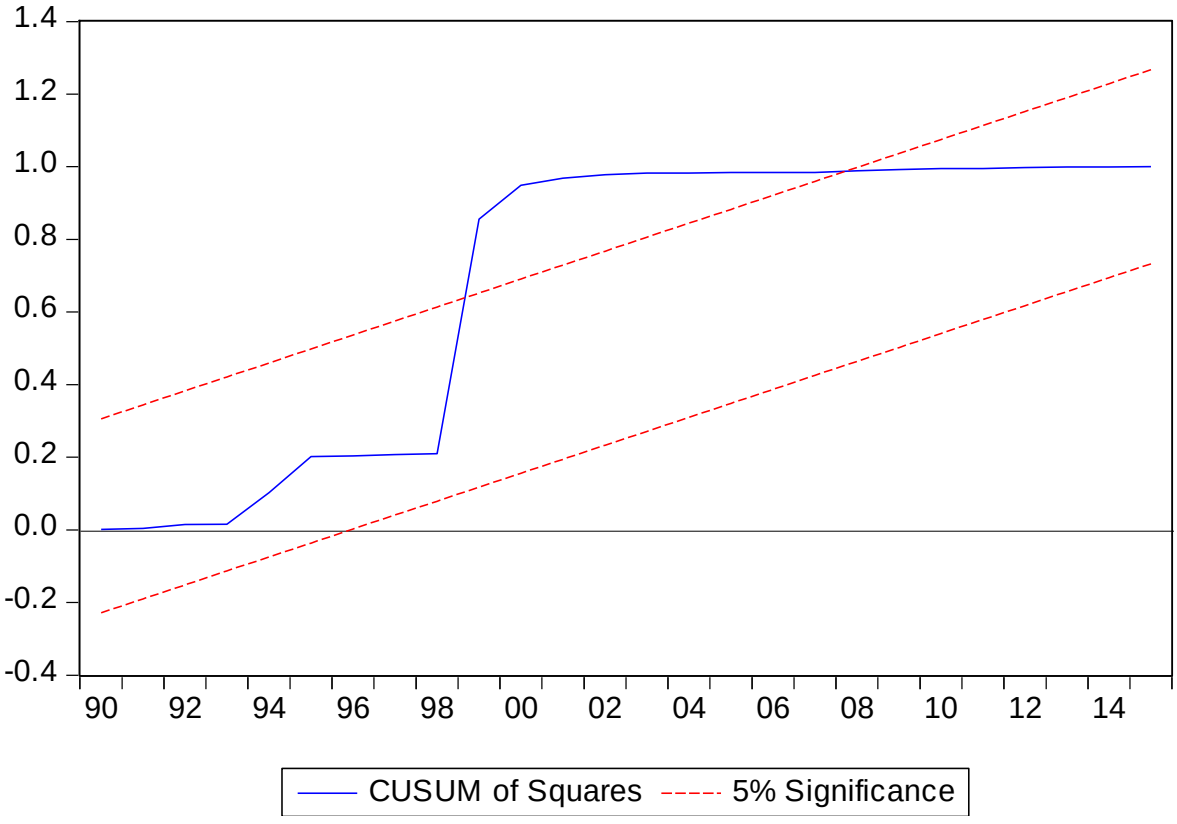


Figure 2 Test of Stability between Crude Oil Price Volatility and Real Exchange Rate



4.3 Discussion of Findings

Results obtained from the estimated exchange rate and granger causality equations, shows some interesting findings. These findings are discussed below:

Exchange rate model

Long and short run coefficients of Nigeria money supply (LM1) are negatively related to real exchange rate and are both statistically significant in Nigeria. This implies that money supply is a crucial determinant of exchange rate in Nigeria. Thus, increase in supply of money (broad money, M1) in Nigeria depreciates the naira. This result support proposition of monetary theory which says, increase in supply of money relative to foreign money supply leads to depreciation of local currency. This also conforms to the findings of Kaushik et al. (2014).

Long run coefficient of U.S money supply converted to naira (LUSM2N) is positive and statistically significant. This conforms to monetary theory which states that an increase in foreign money supply relative to domestic money supply will appreciate the value of the domestic currency. It implies that U.S money supply exert little influence on naira exchange rate in the long run. In short run, U.S money supply exerts negative influence on Nigeria's real exchange rate in current period but positive in one period lag of U.S money supply.

Long and short run coefficients of Nigeria gross domestic product (GDP, LY1) are statistically significant and positive. This implies that GDP is an important factor that influences exchange rate in Nigeria. This also conforms to the findings of Kaushik et al. (2014) and monetary theory of exchange rate determination which states that increase in domestic productivity in relation to foreign productivity appreciate the domestic currency. U.S gross domestic product (GDP, LUSY2N) exert positive but insignificant impact on real exchange rate in Nigeria as shown by long and short run coefficients. However, one period lag of U.S GDP exerts negative but insignificant influence on exchange rate in Nigeria. The signs of current period long and short run coefficients of U.S GDP are not in conformity with the monetary theory of exchange rate determination because increase in foreign GDP in relation to domestic GDP depreciates value of the domestic currency, all things being equal. Though, one period lag of U.S GDP in short run is correctly signed but not significant.

Interest rate differential (INRD) exerts significant and negative impact on real exchange rate as shown by long and short run coefficients. This implies that, lending interest rate is also an important determinant of exchange rate in Nigeria. This is evidence from the high lending interest rate banks charge investors and potential investors and give little interest as deposits rate. Thus, this result also conforms to the findings of Ahmed et al. (2016) and monetary theory which states that increase in domestic interest rate in relation to foreign interest rates leads to depreciation in exchange rate.

The results also revealed that, in the long run, Nigeria consumer price index (NCPI) proxy for inflation exert significant and positive impact on real exchange rate. This result contradicts the monetary theory of exchange rate which prescribes that, a country that intends to strengthen its exchange rate must lower general price level. However, in the short run, NCPI exert insignificant and positive impact on real exchange rate in Nigeria as in long run estimate. This finding is line with the study of Ahmed et al. (2016) that found that consumer price index volatility exert positive impact on real exchange rate. This contradiction on the impact of inflation on real exchange rate may be due to fact that, economic theories support low and stable inflation rate for economic growth. Similarly, the sample size of this study might have also contributed to this contradiction.

Finally, crude oil price volatility and real exchange rate showed significant and negative relationship in the long run. This implies that crude oil price volatility has significant and negative effect on real exchange rate in Nigeria as shown by estimated long run coefficient. This finding is in line with the correlation matrix and commodity currency and exchange rate theory which state that changes in crude oil terms of trade will lead to variation in real exchange rate. However, the coefficient of the short run estimate further upheld the negative relationship between crude oil price volatility and real exchange rate but not statistically significant. This finding is in line with the study of Onoja (2015) that found oil price volatility do not have impact on real exchange rate in the short run. This implies that crude oil price volatility have negative impact on real exchange rate in the short run but not significant. The pair-wise granger causality result revealed no causality between crude oil price volatility and real exchange rate in Nigeria. This finding contradicts the findings of Komain (2015) and Apere and Ijomah (2013) whose studies found causality between crude oil price volatility and real exchange rate. The recursive test result showed stable relationship using CUSUM plot. CUSUMSQ plot on the other hand, showed unstable relationship.

V. SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Summary of Findings

After applying theoretical and econometric tools to thoroughly analyze impact crude oil price volatility has on exchange rate, the following summarized findings were derived from the study.

I. Oil price volatility exerts negative impact on Nigeria's exchange rate. This was evidence from negative signs of the long and short run coefficients of volatility of crude oil price. This negative relationship was further confirmed by the results of the correlation matrix.

II. Crude oil price volatility has more impact on exchange rate in the long run than short run. This was proven by value and statistical significance of the negative signed volatility of crude oil price in the long run, although not significant in the short run. This result is in conformity with the finding of Onoja (2015), who opined that crude oil price fluctuations does not have impact on exchange rate in the short run.

III. The most interesting findings are; Nigeria money supply, Nigeria GDP and interest rate differential are important determinants of real exchange rate movement in Nigeria in both long and short runs respectively. These were evidence from their correct theoretical signs and statistical significance in both long and short runs exchange rate equations.

5.2 Policy Recommendations

Based on the findings above, the following policy recommendations were made:

I. The negative impact of crude oil price volatility on naira's exchange rate calls for urgent shift in Nigerian economy from crude oil export to none oil export through the exploration of other solid minerals and even agricultural produce. This is because Nigeria does not have control over crude oil price. Thus, diversification away from oil or primary product export will go a long way in reducing frequent fluctuations in the value of the naira.

II. Since crude oil price volatility affects exchange rate more in the long run, it is expedient for Nigeria to make swift effort to increasing her foreign reserves in the short run since it act as a shock absorber against volatility of crude oil price. Thus, Nigeria should make deliberate effort in increasing her reserve in the short run through careful management of available foreign exchange policy, promoting export through incentives and disincentives to consume non-essential imports, granting foreign borrowing right only to sectors that promotes economic growth especially of activities that earns foreign exchange so as to prepare for the long-run impact of volatility of crude oil price.

III. Finally, the negative relationship between real exchange rate and money supply means Nigeria must constantly keep her broad money supply in check so as to avoid excess money supply that is capable of causing demand pull inflation and encourage the importation of goods from abroad to meet the increasing demand for goods in the domestic economy. Similarly, since lending interest rate proves to be an important factor in influencing the value of the naira in both the long and short runs through fall in output, fiscal stimulus is required through prompt passage of the budget and implementation.

5.3 Conclusion

This study was conducted to empirically examine the impact of crude oil price volatility has on exchange rate by employing secondary data from 1986 to 2015. Various descriptive and econometric techniques were used to estimate the relationships among variables in the exchange rate equation. The assumption of this study was that crude oil price fluctuations have significant impact on exchange rate in Nigeria. This is because the current fluctuation in exchange rates Nigeria is experiencing now was prompted by the sudden plunge in crude oil in 2014. However, whether this assumption hold for Nigeria using specific theories and the ARDL model remains an empirical issue and that was the primary objective for undertaking this study.

The empirical results showed that the variables are co-integrated and crude oil price volatility exerts negative impact on exchange rate in the long and short runs but this impact was only significant for the long run exchange rate equation. This implies that crude oil price plays significant role in influencing exchange rate in the long run while other variables might account for fluctuations in the short run. It also revealed Nigeria money supply, Nigeria GDP, and lending interest rate differential are key determinants of exchange rate in the long and short runs in Nigeria.

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