Determinants of Exchange Rate Volatility: New Estimates from Nigeria

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Significance and Impact of the Study: This study is significance because the knowledge of the factors that causes exchange rate volatility will guide the monetary authority, investing public, financial analysts and researchers in making informed economic and financial decisions.

ABSTRACT

This study investigates the sources of exchange rate volatility in Nigeria from 1989Q1 to 2015Q4. The volatility of exchange rate was obtained through the use of Autoregressive Conditional Heteroscadasticity (ARCH) model. The study further employed Autoregressive Distributed Lag (ARDL) model and Granger Causality test to estimate the relationship between exchange rate volatility and its determinants in Nigeria. The findings revealed that net foreign asset and interest rate have positive and statistically significant impact on exchange rate volatility while fiscal balance, economic openness and oil price have positive and statistically insignificant impact on exchange rate volatility. Furthermore, nominal gross domestic product has negative and statistically insignificant impact on exchange rate volatility. Result of Granger Causality test reveals that there is bidirectional causality running from both fiscal balance and exchange rate volatility whereas unidirectional causality runs from economic openness and oil price to exchange rate volatility. There is however, no evidence of causality between net foreign asset, nominal gross domestic product and interest rate on one hand and exchange rate volatility. Consistent with the findings, the study recommends that government should increase the holding of foreign asset in order to ensure surplus or balance in the current account and there is need for the Central Bank of Nigeria to ensure a stable interest rate in the economy with a view to realize stable exchange rate.

Keywords: *Exchange rate volatility, ARDL, ARCH, Granger causality.*
JEL Classification: *C32, C38, F02, F31.*

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1. INTRODUCTION

The importance of exchange rate stability in the attainment of macroeconomic policy objectives in both developed and developing economies cannot be over emphasized. Exchange rate is one of the determinants used in assessing the performance of an economy. A very strong exchange rate is a reflection of a strong and viable economy. On the other hand, a very weak currency is a reflection of a very vulnerable and weak economy. Governments, particularly in developing economies over the years have adopted different exchange rate management policies with a view to achieve realistic and stable exchange rate. Thus, most of these countries experienced high exchange rate fluctuation which translates into high degree of uncertainty or volatility. Exchange rate volatility is associated with unpredictable movements in the relative price in the economy. It also refers to the swings or fluctuations in the exchange rate over a period of time or deviations from a benchmark or equilibrium exchange rate. Exchange rate volatility is an important contributor to risk in the financial world. During the period of excessive movements in exchange rates, foreign trade and investments could be affected negatively (Mordi, 2006; Ajao and Igbokoyi, 2013; Insah and Chiaraah, 2013).

The problem of exchange rate volatility in Nigeria can be traced to the mid-1980s, when Structural Adjustment Programmes (SAP) was introduced. One of the objectives of SAP was to achieve a realistic and stable exchange rate of Naira. Since then, the exchange rate between naira and other currencies of the world especially US dollar has been very volatile. It fluctuates on weekly, daily and even hourly basis and there is no limit to its variability. This fluctuation has made naira to be very unstable and its value difficult to ascertain. This problem of exchange rate uncertainty became too disturbing and over the years has been a source of great concern to policy makers, policy analysts, domestic as well as foreign investors (Stephen and Sanmi, 2011).

Nigeria has adopted different systems of exchange rate control with the aim of attaining favorable and stable exchange rate. Among them are inter-bank foreign exchange market (IFEM) in 1989, fixed exchange rate in 1994, autonomous foreign exchange market in 1995, re-introduction of inter-bank foreign exchange market in 1999, and the introduction of W-DAS in 2006 among others. In spite of these mechanisms that have been introduced to stabilize the exchange rate, a realistic and stable exchange rate has remained elusive. During the period under review (1989Q1–2015Q4) there has been persistence depreciation in naira exchange rate. The most alarming of this was recorded in1989, 1994, 1999, 2001, 2002 and 2013 when the exchange rate of naira to dollar was ₦12.94 = $1.00, ₦21.89 = $1.00, ₦92.56 = $1.00, ₦111.90 = $1.00, ₦128 = $1.00 and ₦157.42 = $1.00 respectively (Aliyu, 2011; The Nation Newspaper, 2014; Omotosho, 2015).

This undesirable trend has led to the emergence of series of empirical studies (see for instance (Adeoye and Atanda, 2010; Englama *et al.*, 2010; Aliyu, 2011; Stephen and Sanmi, 2011; Ajao and Igbokoyi, 2013; Bala and Asemota, 2013) in the area. But surprisingly, none of these studies investigate the direction and nature of causality between exchange rate volatility and its determinants in Nigeria.

Similarly, since the collapse of the Bretton Wood System in 1973, there has been a renewed interest worldwide into the study of exchange rate volatility and its determinants. Studies have revealed that economic openness, terms of trade, net foreign assets, government expenditure, money supply, commodity price, inflation, economic growth, interest rate, fiscal balance among the others as the determinants of exchange rate volatility (Stancik, 2007; Villavicencio and Bara, 2008; Al-Samara, 2009; Asiama and Kumah, 2010; Razi *et al.*, 2012; Insah and Chiaraah, 2013). Equally in Nigeria many empirical studies have been conducted on exchange rate volatility (see (Adeoye and Atanda, 2010; Englama *et al.*, 2010; Aliyu, 2011; Ajao and Igbokoyi, 2013; Bala and Asemota, 2013)) but these studies ignored the impact of fiscal balance on exchange rate volatility in Nigeria.

This paper is an attempt to redress the short comings observed in the literature by employing a more robust technique of analysis i.e. Autoregressive Distributed Lag (ARDL) bound testing approach to explore the relationship between exchange rate volatility and its determinants in Nigeria.

To achieve our objective, the paper is structured into five sections: the next section provides a review of the literature on the determinants of exchange rate volatility. Section three presents data and methodology. While the fourth section presents the results of the analysis, the fifth section concludes the paper.

2. LITERATURE REVIEW

This section is presented in two sub-sections. The first is the theoretical framework which provides a review of theories on which our analysis is anchored on. The second sub-section is an empirical review of previous studies.

2.1. Theoretical Framework

The theoretical underpinning for the determination of exchange rate behavior is rooted in both monetary and macroeconomic theories. The monetary theory assumes highly the integration of goods and capital markets. The theory reinforces the assertion of purchasing power parity (PPP) doctrine which was introduced by Gustav Cassel in 1970 to determine the exchange rate between the currencies of two countries (Jhingan, 2008). Purchasing power parity holds that the rate of exchange between two currencies must be equal to the ratio of total price levels between two countries (Asab *et al*., 2015).

The second theory that underpins exchange rate determination is known as macroeconomic (real) theory. This phenomenon centers its attention on the function played by the macroeconomic fundamentals (variables) in the determination of exchange rate behavior (Villavicencio and Bara, 2008). This approach is divided into two – The Balassa-Samuelsson doctrine and the balance of payments approach. The Balassa-Samuelson approach was introduced in 1964.The doctrine centers its attention on the balance between tradable and non-tradable sectors.

On the other hand, the balance of payments approach was introduced by Nurkse in 1945. According to this theory, exchange rate of a country is determined by its balance of payment. A favorable balance of payment overvalued the exchange rate, while unfavorable balance of payments undervalues exchange rate of a country. Thus, demand for and supply of foreign exchange play an important role in the determination of exchange rate in the foreign exchange market. The debit side of the balance of payments takes care of the demand for foreign exchange. This is due to payments made to the foreign country for goods and services traded from them plus loans and investments made outside the economy. Also, the supply side arises from the credit side of the balance of payments. It comprises payments for goods and services traded from the domestic economy, plus loans and investments made within the economy. The theory further states that, balance of payments account is balance, if debit side and credit side of the account are equal. If credit side of the account exceeds its debits side, it is known as favorable balance of payments. However, if the debit side exceed credit side of the account, this results in an unfavorable balance of payments (Jhingan, 2008).

Under balance of payments approach, many notions of equilibrium exchange rates have been introduced. one of them is the Capital Enhanced Equilibrium Exchange Rates-CHEER. The central idea behind this notion is the combination of functions of both uncovered interest rate parity and purchasing power parity in obtaining well defined measures of the equilibrium exchange rate. It also focused on the interaction between exchange rate and capital account items. It ignores the role of relative output terms and net foreign assets. The essential assertion of this approach is that, there is a long-run relationship between real exchange rate and interest rate differentials (MacDonald, 2000).

As noted by MacDonald (2000) Behavioral Equilibrium Exchange Rates (BEERs) is another notion that determine the behavior of exchange rate. The BEERs includes both current and capital account items of the balance of payments as determinants of real exchange rate behavior. This approach capture a set of long-run and medium term relationship between real exchange rate and macroeconomic fundamentals that are delivered from the determinants of saving, investment and current account and a set of transitory factors influencing the real exchange rate in the short-run (Villavicencio and Bara, 2008; Asiama and Kumah, 2010).

The Fundamentals Equilibrium Exchange Rates (FEERs) is another alternative measure to exchange rate behavior.FEERs is an internal – external approach to equilibrium exchange rate. The FEER is defined as the real exchange rate that achieves both internal and external balances at the same time. Internal balance is achieved when the economy is at full employment level of output and operating in a low inflation environment. External balance is achieved when the economy is at optimum balance of payments positions over the medium term, ensuring desired net flows of factors and external debt sustainability (MacDonald, 2000; Al-Samara, 2009).

Another approach to real exchange rate is the Natural Exchange Rate (NATREX), introduced by Stein in 1994. NATREX combined the functions of both FEERs and BEERs in the process of measuring real exchange rate behavior. It is the notion that permits the attainment of both internal and external balances. Furthermore, NATREX modelled current account due to the dynamic behavior of savings and investments (Villavicencio and Bara, 2008; Asiama and Kumah, 2010).

This paper adopted the fundamentals equilibrium exchange rate (FEERs) approach to underpin the relationships between the macroeconomic fundamentals (variables) and exchange rate volatility in Nigeria. The reason behind the adoption of this approach is that equilibrium exchange rate is achieved via internal-external balances. Internal balance is attained when the economy is operating at desired output level (full employment) and low inflation, while external balance represents the situation in which the economy is experiencing favorable balance of payments, ensure preferred net flow of resources and realize external debt sustainability.

2.2. Review of Empirical Literature

There has been tremendous growth of empirical literature on the determinants of exchange rate volatility since the breakdown of the Bretton Woods in 1973 to date. Below are some of the empirical studies which attempt to investigate the determinants of exchange rate volatility.

Stancik (2007) investigated the sources of exchange rate volatility among European Union members' countries. The study used threshold autoregressive conditional heteroscadasticity (TARCH) model as a technique of analysis. His findings revealed that economic openness, information and flexible exchange rate regimes have positive and statistically significant impact on exchange rate volatility.

The studies by Razi *et al.* (2012) and Saeed *et al.* (2012) in Pakistan revealed that GDP, inflation, interest rate, current account balance, money stock, foreign reserve and total debt were the major factors influencing exchange rate instability in Pakistan.

Al-Samara (2009) investigates the determinants of real exchange rate volatility in Syria over the period of 1980 to 2008. His objective was to identify the principal factors suggested in many theoretical literatures, which includes relative productivity, government expenditure, terms of trade, trade openness and net foreign assets. To examine these variables, the author employed VECM and ARCH. His result reported that relative productivity, total investment and oil price have positive impact on exchange rate volatility; while government expenditure was found to have negative impact. The study suggests that Central Bank of Syria should frequently adopt flexible exchange

rate regime in order to improve bank's autonomy and to promote indirect monetary policy instruments in the economy.

Insah and Chiaraah (2013) empirically investigated the factors affecting real exchange rate volatility in Ghana for the period of 1980 to 2012. The variables of their choice include; government expenditure, money supply, domestic debt and external debt. To examine the relationship, the authors employed ARDL model. Their findings revealed that, there exist positive relationship between government expenditure and exchange rate volatility, while money supply, domestic and external debts were negatively related to exchange rate volatility. The authors recommended that government should cut down its expenditure in order to control the persistence trends in exchange rate.

In another development, Asiama and Kumah (2010) examines the degree of influences upon which productivity, fiscal balance, current account balance, terms of trade, openness, oil prices, public consumptions, foreign direct investment and foreign aids affects exchange rate variability in African countries over the period of 1980 to 2008. The objective of their study was to investigate whether there is evidence of consistency between the theoretical and empirical framework. To test their hypothesis, the authors utilized panel cointegration approach. The study reveals that both theoretical and empirical frameworks were very much consistence, and real exchange rate was strongly influenced by openness, terms of trade and oil prices.

Gelbard and Nagayasu (2004) have added to the literature on the topic by investigating the causes of real exchange rate in Angola for the period spanning from 1992 to 2002. Their results proved that oil price and foreign interest rate were the most important sources of exchange rate movements. They recommended that flexible exchange rate policy is more likely to be the right exchange rate policy for Angola than fixed exchange rate policy.

Furthermore, in Nigeria, there is a dearth of literature on the determinants of exchange rate volatility. The limited evidence on the subject is reviewed below. Ajao and Igbokoyi (2013) examined the degree of influence of real exchange rate, productivity, trade openness and government expenditure, real interest rate and money supply on real exchange rate volatility in Nigeria for the period between 1981 and 2008. Using GARCH and ECM, their empirical results indicates that real exchange rate, trade openness, government expenditure, real interest rate have positive impact on exchange rate volatility in Nigeria with exception of money supply and productivity.

Adeoye and Atanda (2010) studied the consistency, persistency and degree of exchange rate volatility in Nigeria, using monthly time series data from 1986 to 2008. The study used ARCH and GARCH models to analyze the long-run consistency of exchange rate volatility in Nigeria, the authors employed purchasing power parity model. The results revealed that both nominal and real exchange rate volatility were persistent in Nigeria. The results also indicated that purchasing power parity was not consistent with nominal exchange rate volatility in Nigeria. The authors recommended that monetary authority should control the higher demand for foreign currencies.

Aliyu (2011) empirically investigated real exchange rate misalignment in Nigeria based on behavioral equilibrium exchange rate (BEERs) approach. Quarterly time series data were used from 1986Q1 to 2006Q4. The author utilized Johansen cointegration test and error correction model. The variables controlled were net foreign assets, terms of trade, and index of crude oil price volatility, government fiscal stance, monetary policy, productivity, trade openness and foreign reserve. The results showed that long-run behavior of real exchange rate was positively influenced by terms of trade, index of crude oil volatility, index of monetary policy performance and net foreign assets, while government spending and foreign reserve were negatively related to real exchange rate behavior. The results also reported that an increase in oil revenue and sound macroeconomic performance could

overvalue or undervalue real exchange rate in Nigeria. The author recommends sound (effective) monetary policy and reduction of fiscal dominance.

Englama *et al.* (2010) examined the relationship between oil price, demand for foreign exchange, external reserve and exchange rate volatility in Nigeria. Monthly series for the period of 1999:1 to 2009:12 were used by the authors. The authors also employed vector autoregressive (VAR) model, cointegration and vector error correction model (VECM) in order to investigate both short-run and long-run relationship between dependent and independent variables. The results showed that exchange rate volatility was strongly influenced by changes in oil price at the foreign market both in the long-run and short-run. In the long-run, a 1.0 percent increase in oil price volatility leads to 0.54 percent change in the exchange rate volatility. While 1.0 percent changes in the demand for foreign currency may generate 14.8 percent change in exchange rate volatility. However, in the short-run, the results showed that 1.0 percent change in oil price at the international market may influence exchange rate volatility to change by 0.02 percent. The study recommends that CBN should target demand for foreign exchange in order to maintain economic stability.

3. DATA AND METHODOLOGY

This paper used quarterly data spanning the first quarter of 1989 to the last quarter of 2015 for the estimation. The data is obtained from Statistical Bulletin of the Central Bank of Nigeria (CBN). The variables included in the model are exchange rate volatility (ERVOL), net foreign asset (NFA), fiscal balance (FB), economic openness (OPEN), oil price (OIL), nominal gross domestic product (NGDP) and interest rate (IR). Furthermore, the model expressing the functional relationship between exchange rate volatility and its determinants is given as:

ERVOL = f (NFA, FB, OPEN, OIL, NGDP, IR) (3.1)

The econometric model is given as:

$$ERVOL_t = \beta_O + \beta_1 NFA_t + \beta_2 FB_t + \beta_3 OPEN_t + \beta_4 OIL_t + \beta_5 NGDP_t + \beta_6 IR_t + \mu_t \quad (2) \text{ (3.2)}$$

The study adopts Autoregressive Distributed Lag (ARDL) approach developed by Pesaran *et al* (2001) to estimate equation (3.2). The choice of the ARDL is based on the following reasons: first, the model can be applied irrespective of whether the series under investigation are stationary at I(0) or I(1) or mixture of both. Second, it provides robust and high quality result even if sample size is small or large. Finally, it takes into account the error correction model. The analysis of error correction and autoregressive lags fully covers both long-run and short-run relationships of the variable under study (Pesaran *et al*; 2001 and Villavicencio and Bara; 2008). Following the work of Pesaran *et al* (2001), the ARDL model of equation (3.2) is given as:

$$\Delta ERVOL_t = \beta_o + \sum_{i=1}^{m} \beta_1 \Delta ERVOL_{t-i} + \sum_{i=1}^{m} \beta_2 \Delta NFA_{t-i} + \sum_{i=1}^{m} \beta_3 \Delta FB_{t-i} + \sum_{i=1}^{m} \beta_4 \Delta OPEN_{t-i} +$$

$$\sum_{i=1}^{m} \beta_5 \Delta OIL_{t-i} + \sum_{i=1}^{m} \beta_6 \Delta NGDP_{t-i} + \sum_{i=1}^{m} \beta_7 \Delta IR_{t-i} + \alpha_1 ERVOL_{t-1} + \alpha_2 NFA_{t-1} +$$

$$\alpha_3 FB_{t-1} + \alpha_4 OPEN_{t-1} + \alpha_5 OIL_{t-1} + \alpha_6 NGDP_{t-1} + \alpha_7 IR_{t-1} + \mu_t \quad (3.3)$$

Where m is the optimal lag length which will be determined using Akaike Information Criteria (AIC) and Schwartz Information criteria (SIC), Δ is the difference operator, β_0 in each equation is the constant parameter, β_1 to β_7 are the vectors of the coefficients of the first difference lagged values of the variables controlled in the models,

while α_1 to α_7 for each equation represent the coefficients of the level lagged values of variables captured in models. The ARDL model consist of two parts, the first part of the equations with β_1 to β_7 stand for the short-run dynamics of the models, while the coefficients α_1 to α_7 represents the long-run relationship. The null hypothesis of the above models is defined as H_0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 = 0$ which tell us that there is no cointegration (no existence of long-run relationship) among the variables under consideration whereas the alternative hypothesis is defined as H_1: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq \alpha_7 \neq 0$ which signify the existence of cointegration presence or evidence of long-run relationship (Pesaran *et al.*, 2001).

We begin the estimation by conducting a bounds (ARDL) test for the null hypothesis of non-existence of long-run relationship (lack of cointegration). The calculated F-statistics is compared with the critical value as tabulated by Pesaran *et al.* (2001). If F-statistics exceeds or supersedes the upper critical value, then the decision rule will be to reject the null hypothesis of no long-run relationship (no cointegration) irrespective of whether the underlying order of integration of the variables is zero or one i.e. I(0) or I(1), whereas if F-statistics falls below a lower critical value, then the null hypothesis cannot be rejected and if F-statistics falls within these two critical bounds, then the result is inconclusive. When the order of integration of the variables under consideration is known and that all the variables are integrated to the order of one I(1), the decision is made based on the upper bound. Also, if all the variables under control are integrated of order zero I(0), the decision is made based on the lower bound (Pesaran *et al.*, 2001).

When there is an evidence of cointegration among the variables, it then becomes necessary to explore the existence of short-run relationship based on error correction mechanism. The general error correction version of equation (3.3) is given as:

$$\Delta ERVOL_t = \beta_0 + \sum_{i=1}^{m} \beta_1 \Delta ERVOL_{t-i} + \sum_{i=1}^{m} \beta_2 \Delta NFA_{t-i} + \sum_{i=1}^{m} \beta_3 \Delta FB_{t-i} + \sum_{i=1}^{m} \beta_4 \Delta OPEN_{t-i} +$$

$$\sum_{i=1}^{m} \beta_5 \Delta OIL_{t-i} + \sum_{i=1}^{m} \beta_6 \Delta NGDP_{t-i} + \sum_{i=1}^{m} \beta_7 \Delta IR_{t-i} + \beta_8 ECM_{t-i} + \mu_t \qquad (3.4)$$

Where ECM is the error correction representation of equation (3.4).

Furthermore, before estimating equation (3.3), the study generated exchange rate volatility through the use of ARCH model developed by Engel (1982) and unit root tests were conducted using Augmented Dickey-Fuller and Phillips-Perron tests. Also, after estimating equation (3.3), the Granger Causality test was conducted to estimate the nature and direction of causality between exchange rate volatility and its determinants.

4. RESULTS

4.1. Estimated Exchange Rate Volatility

Exchange rate volatility was generated using ARCH model. The output from ARCH model is divided into two parts; first part (upper part) gives the output of the mean equation and the second part (lower part) presents the result of variance equation. The results are presented in Table 4.1

Table-4.1. Testing for ARCH (1) Effects in Exchange Rate

Mean Equation		
	Coefficient	**P-Value**
Constant	5.5261	0.0000
Exch. Rate(1)	0.9664	0.0000
Variance Equation		
Constant	9.2318	0.0002
RESID(-1)	3.0741	0.0037
ARCH LM Test		
F-statistics	0.076067	0.7833

R2 = 0.99, DW =1.6, AIC = 6.47, SIC = 6.58, HQC = 6.51
Source: Authors' computation using Eviews Version 9

From Table 4.1, the estimated means and variance equations are significant at 1% level. This suggests that ARCH (1) model is well fitted in modeling exchange rate volatility in Nigeria during the study period (i.e. 1989Q1 to 2015Q4). Furthermore, to check the evidence or presence of heteroscadasticity in the residuals, an ARCH (1) LM test was conducted. The results revealed that, there is no evidence of ARCH effects. This is shown by the insignificant p-value of F-statistics which stands at 0.7833. From the test results we can conclude that, there is an evidence of volatility in the exchange rate, hence ARCH (1) model is suitable for modeling exchange rate volatility in Nigeria during the study period.

4.2. Unit Root Test Result

The study investigated the stationarity level of the variables under study in order to ensure that none of series is integrated beyond order one i.e. I(1). To achieve the foregoing, unit root tests were conducted using Augmented Dickey Fuller (ADF) and Phillip-Perron (P-P) tests and the results revealed that none of the series go beyond integrated of order one i.e. I(1). The ADF and P-P results showed that exchange rate volatility, economic openness, interest rate were all stationary at level value i.e. I(0). While net foreign assets, oil price and nominal GDP were stationary at first difference value i.e. I(1). This is because, in absolute term, their actual values are greater than their respective critical values, which indicates that; null hypothesis which stipulates that, the series are not stationary is rejected. However, the ADF results both at level and first difference values show that fiscal balance is not stationary. Whereas P-P result revealed that fiscal balance is an I(1) series. The summary of the unit root tests are presented in Table 4.2.

Table-4.2. Unit Root Test (Augmented Dickey-Fuller and Phillips-Perron)

Variables	**Augmented Dickey-Fuller Test**		**Phillips-Perron Test**	
	Level Value I(0)	**First Diff. I(1)**	**Level Value I(0)**	**First Diff. I(1)**
ERVOL	-10.0384***		10.0382***	
NFA	-1.754	-3.4485*	-1.9971	-7.5794***
FB	-2.5143	-2.8933	-1.8058	-3.7777**
OPEN	-3.4977**		-3.7614***	
OIL	-2.3763	-8.6323***	-2.4808	-6.6063***
NGDP	4.1642	-3.2124*	2.6811	-8.7920***
IR	-3.6543***		-3.6602***	

Note: Significant at 1% (***), 5% (**), and 10% (*).
Source: Authors' calculation using Eviews Version 9

Table 4.2 shows that, exchange rate volatility, economic openness and interest rate are integrated of order I(0), while net foreign asset, fiscal balance, oil price and nominal GDP are of order I(1) thereby providing support for the use of ARDL as an estimation technique.

Table-4.3. Result of Estimated Long-Run Coefficients (ARDL)

(Dependent Variable: ERVOL)				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
LNFA	0.560	0.269	-1.988	0.050
FB	0.000	0.000	0.938	0.351
LOPEN	0.215	0.421	-0.487	0.628
LOIL	0.074	0.315	-0.224	0.823
LNGDP	-0.336	0.323	0.991	0.325
LIR	1.674	0.704	-2.266	0.026

R2 = 0.62, F Stats=7.25; (6,80) [0.000]
Adjusted R2 = 0.54 AIC=2.640; SBC=3.091; 2.822; DW=1.968
Note: The relevant critical values for unrestricted intercept and unrestricted trend for k=6 is 3.34 and 4.63 at 1.0 per cent level of significance. They are obtained from Pesaran *et al.* (2001) Table CI(v): Unrestricted intercept and unrestricted trend
Source: Authors' Calculation using Eviews Version 9

From Table 4.3, the F-calculated (i.e. 7.25) reveals that the null hypothesis of no cointegration can be rejected at 1% significant level. This is because the F-statistics is higher or greater than the upper bound critical value of 4.63 and 3.34 for lower critical bound for k equals to 6, as tabulated in Pesaran *et al.* (2001) – Table CI(V) unrestricted intercept and unrestricted trend. Moreover, the ARDL result reveals that, net foreign asset is positively associated with exchange rate volatility (i.e. 0.560) and is statistically significant at 5% level. Implying that an increase (decrease) in net foreign asset leads to increase (decrease) in exchange rate volatility. For instance, a one percentage change in net foreign asset leads to about 0.56 percentage change in exchange rate volatility. Also, fiscal balance has positive and insignificant weak relationship with exchange rate volatility in Nigeria. According to the regression result fiscal balance is not the main source of exchange rate volatility during the study period.

Similarly, economic openness has direct relationship with exchange rate volatility. A 1% change in economic openness leads to about 0.22% change in exchange rate volatility. Hence the result shows that economic openness is not a major determinant of exchange rate volatility in Nigeria during the study period as shown by its p-value of 0.628 which is statistically not significant. Additionally, oil price has positive and statistically insignificant impact on exchange rate volatility. From the result, a unit change in oil price leads to about 0.07 percentage change in exchange rate volatility. The result however reveals that oil price is not a statistically significant determinant of exchange rate volatility in Nigeria from 1989Q1 to 2015Q4. This portrays the true picture of the Nigerian economy as import dependent. This is because irrespective of whether there is an increase or decrease in oil price the value of Naira in relation to US dollar is persistently on the decrease.

Furthermore, nominal GDP displays a negative and statistically insignificant relationship with exchange rate volatility. This indicates that an increase (decrease) in nominal GDP leads to decrease (increase) in exchange rate volatility. A one percentage increase in nominal GDP leads to about 0.34 percentage point decrease in exchange rate volatility. Notwithstanding this result, nominal GDP is not a statistically significant source of exchange rate volatility in Nigeria from 1989Q1 to 2015Q4.

Finally, interest rate is positively associated with exchange rate volatility (i.e. 1.674) and statistically significant at 5.0 percent. This indicates that an increase (decrease) in interest rate leads to leads to an increase (decrease) in exchange rate volatility. For instance, a one percentage change in interest rate leads to about 1.674 percentage changes in exchange rate volatility.

4.3. Result of the Estimated Short-Run Relationship

The short-run nexus between exchange rate volatility and the explanatory variables was estimated using error correction model (ECM). The error correction coefficient is -0.7032 and statistically significant at 1% level going by the p-value of 0.0002. This shows a high speed of adjustment to equilibrium level in case of any distortion in the

economy. This corroborates the long-run relationship. For the explanatory variables, the short-run analysis shows the presence of negative significant relationship among net foreign assets, nominal GDP and exchange rate volatility during the study period. Whereas significant positive relationship exists between exchange rate volatility and fiscal balance as shown by the short-run result in Table 4.4.

Table-4.4. Error Correction Estimates of the ARDL Model (Short-Run Dynamics)

Dependent Variable: ΔERVOL				
Variable	**Coefficient**	**Std. Error**	**t- Statistic**	**Prob.**
C	0.243	0.118	2.062	0.042
ΔLERVOL(-1)	-0.264	0.132	-1.996	0.049
ΔLERVOL(-2)	-0.206	0.109	-1.879	0.064
ΔLERVOL(-3)	-0.165	0.092	-1.785	0.078
ΔLNFA(-2)	-1.187	0.515	-2.306	0.024
ΔFB(-2)	-7.020	2.420	-2.896	0.005
ΔFB(-4)	1.180	2.490	4.727	0.000
ΔLOPEN(-2)	0.477	0.509	0.938	0.351
ΔLOIL(-3)	-1.082	0.663	-1.632	0.106
ΔLNGDP(-4)	-2.374	0.848	-2.799	0.006
ΔLIR(-1)	-1.096	0.961	-1.140	0.257
ECM(-1)	-0.703	0.183	-3.852	0.000

R2 = 0.53 Adjusted R2 = 0.47, Durbin Watson = 1.7764, Prob.(F-stat.) = 0.0000
Source: Authors' calculation using Eviews version 9

Table-4.5. Result of the Granger Causality Test

Null Hypotheses	**Lags**	**Obs.**	**F-statistics**	**P-values**
DNFA does not Granger Cause DERVOL	4	102	0.71249	0.5855
DERVOL does not Granger Cause DNFA	4	102	0.17946	0.9485
DFB does not Granger Cause DERVOL	4	102	4.00041	0.0050
DERVOL does not Granger Cause DFB	4	102	3.32347	0.0139
DOPEN does not Granger Cause DERVOL	4	102	2.2484	0.0701
DERVOL does not Granger Cause DOPEN	4	102	0.1708	0.9528
DOIL does not Granger Cause DERVOL	4	102	3.0037	0.0225
DERVOL does not Granger Cause DOIL	4	102	1.0945	0.3643
DNGDP does not Granger Cause DERVOL	4	102	0.3753	0.8257
DERVOL does not Granger Cause DNGDP	4	102	1.3479	0.2585
DIR does not Granger Cause DERVOL	4	102	0.4574	0.7667
DERVOL does not Granger Cause DIR	4	102	1.8485	0.1266

Source: Authors' calculation using Eviews version 9

As presented in Table 4.5, the Granger causality result shows that, there is no relationship between net foreign assets and exchange rate volatility. This is because F-statistic is not significant event at 10% level. Therefore, null hypotheses could not be rejected going by their respective p-values of 0.5855 and 0.9485. There is bi-directional causality between fiscal balance and exchange rate volatility. This is because at 1% significant level the null hypotheses could be rejected as shown by their p-values of 0.0050 and 0.0139 respectively. However, there is a unidirectional causality running from economic openness to exchange rate volatility as indicated by the p-value of 0.0701. Additionally, the hypothesis that exchange rate volatility does not Granger cause economic openness could not be rejected going by p-value of 0.9528. Another unidirectional causality is from oil price to exchange rate volatility. This is because at 5% level of significant (0.0225), the null hypothesis which states that oil price does not Granger Cause exchange rate volatility could be rejected. On the other hand, the null hypothesis that exchange rate volatility does not Granger cause oil price could not be rejected as indicated by the p-value of 0.3643. Furthermore, there is no causal relationship between nominal GDP and exchange rate volatility. This is because their respective

p-values (0.8257 and 0.2585) are not significant even at 10% level. Finally, there is no evidence of causality between interest rate and exchange rate volatility. Since their respective null hypotheses could not be rejected going by the p-values of 0.8257 and 0.2585.

5. CONCLUSION AND RECOMMENDATIONS

This paper investigated the sources of exchange rate volatility in Nigeria using quarterly data for the period 1989Q1 to 2015Q4. The empirical analysis found that, net foreign asset and interest rate have positive and statistically significant impact on exchange rate volatility while fiscal balance, economic openness and oil price have positive and statistically insignificant impact on exchange rate volatility. The study however, discovered that nominal GDP has negative and statistically insignificant effect on exchange rate volatility. On the direction of causality, the study reveals that, there is unidirectional causality running from economic openness and oil price to exchange rate volatility, whereas there is no evidence of causality running from net foreign asset, nominal GDP and interest rate to exchange rate volatility. The finding also shows the existence of bidirectional causality between fiscal balance and exchange rate volatility.

The results of this study have some important policy implications. First, net foreign asset has been identified by this study as one of the principal determinants of exchange rate volatility, to maintain stable exchange rate, government should increase the holding of foreign asset in order to maintain surplus or stability in the current account. Second, interest rate has significant effect on exchange rate volatility, therefore, there is need for the Central Bank of Nigeria to maintain stable interest rate as any fluctuation in interest rate will trigger serious threat in maintaining stable exchange rate. Finally, going by the result of the Granger causality, government should take into cognizance past levels (values) of fiscal balance, economic openness and oil price when making exchange rate policy for the future.

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